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BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 86, No. 4, pp. 219–227 JULY, 1959

THE FLOOD PLAIN VEGETATION OF THE MILLSTONE RIVER, NEW JERSEY

GEORGE W. VAN VECHTEN III AND MURRAY F. BUELL

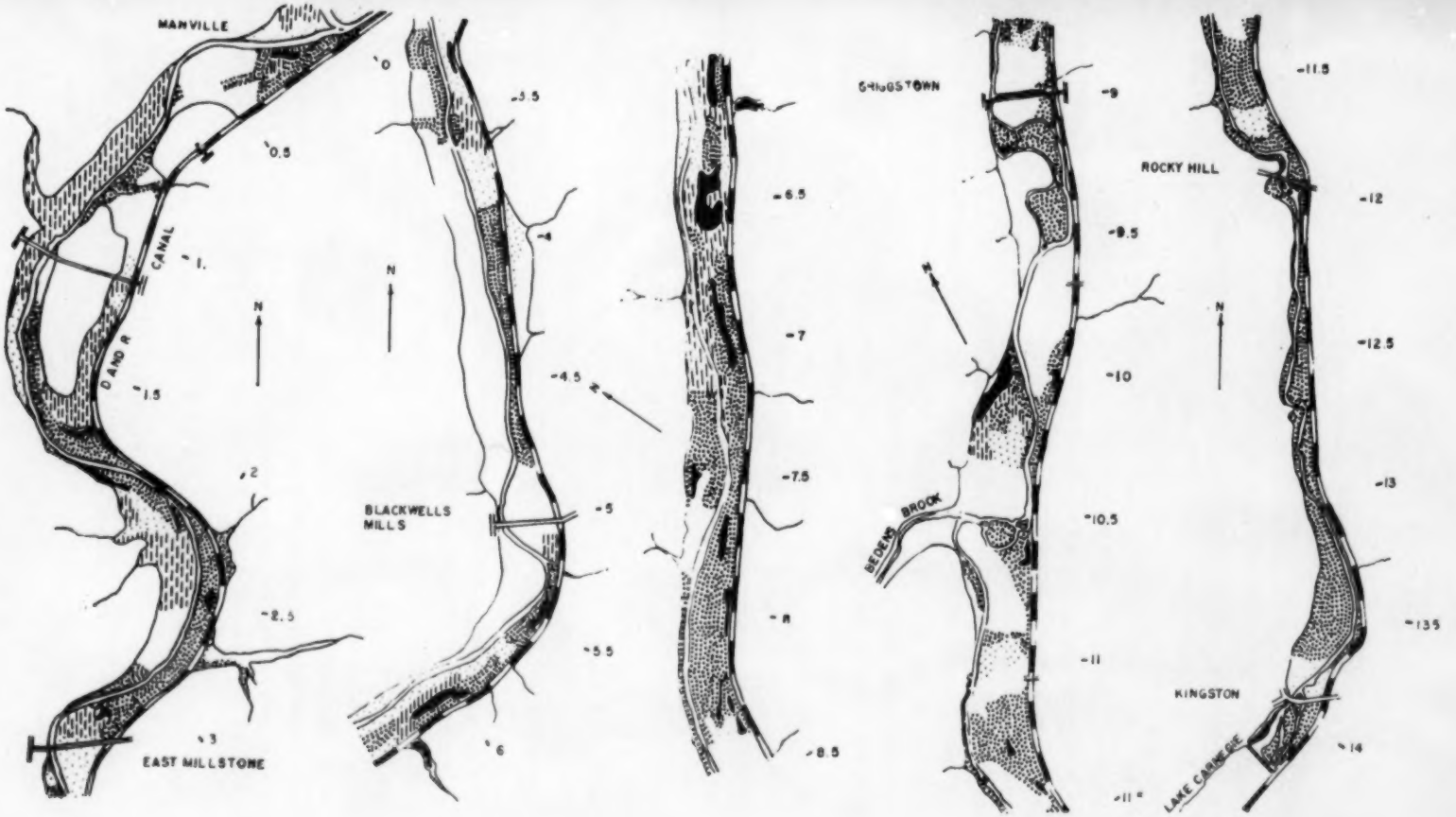
The Millstone River rises in the Tertiary sands of the coastal plain of New Jersey (Lewis and Kummel 1940). Flowing northwest through fertile farming country for about sixteen miles, it crosses Cretaceous sediments. On reaching the piedmont near Princeton, it turns northward and then for much of the rest of the distance passes over the red shale of the Brunswick formation of Triassic age. About the point where it reaches the piedmont, it is joined by Stony Brook, its principal tributary, whose course is entirely over Triassic formations. A dam at Kingston forms Lake Carnegie, and it is the portion of the river below Lake Carnegie about which this study is concerned.

Although this portion of the river flows largely through the red shale, at Rocky Hill there is a short stretch where it crosses diabase. There are also limited amounts of unconsolidated Pleistocene deposits along its course. The geologic map of New Jersey shows stratified drift occurring in places from Princeton north, and the Land Type Map of the New Jersey Agricultural Experiment Station shows the region from Millstone north as outwash plain (Quakenbush and Tedrow 1954). A large deposit of this outwash material occurs within and higher than the flood plain about a mile south of the confluence of the Millstone and the Raritan Rivers (fig. 1, between mile 1 and 1.5). The alluvium of the flood plain has thus been derived from a variety of geological formations.

The flood plain below Lake Carnegie stretches for about 14 miles through the gently rolling piedmont and is about one fifth of a mile wide in most places. Just below the dam at Lake Carnegie the elevation of the flood plain is 45 feet (Vermuele 1894); while at the confluence with the Raritan the elevation above sea level is about 30 feet. The drop is gradual throughout but is sufficient to maintain a steady though gentle flow.

On its eastern edge, the flood plain is bordered by the Delaware and Raritan canal which was opened in 1834. The canal water is maintained at a height above the flood plain by an earthen embankment, and in places seepage occurs. Streams flowing into the river from the east pass under the canal by way of culverts. The canal has isolated the portion of the flood plain between it and the river. On the flood plain between the river and the canal rows of large trees in a line with fence rows on the east side of the the canal give evidence of how the land now abandoned from agricultural use was once continuous with nearby farms.

[THE BULLETIN for May–June 1959 (86: 159–217) was issued July 13, 1959.]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The objectives of this study are to record the present distribution and condition of the vegetation of the Millstone River flood plain between Lake Carnegie at Kingston and its confluence with the Raritan, and to discuss the natural changes taking place in this area.

Methods. The field work was done in the summer of 1956. The entire area was visited on foot, and notes were taken as to the role of the various species, stages of succession, and other features of interest such as disturbance by man. A vegetation map was constructed from these notes with the aid of aerial photographs (fig. 1). The plant nomenclature used is that of Gray's Manual of Botany, eighth edition (Fernald 1950).

Results. Five different categories of vegetation are recognized and presented on the map (fig. 1): 1. Land under agricultural use comprises 33 percent of the area of the flood plain and is largely in pasture. 2. Fields recently used agriculturally but now abandoned to natural revegetation occupy 14 percent of the area. They are fields which have not been disturbed by grazing or plowing for the past few years and are not dominated by forest growth. 3. The areas mapped as young forest are occupied by rapidly growing trees largely under 20 years of age. The growth is often so dense in summer that little light penetrates to the ground and hence there are few shrubs and herbs present. The edges of such woods often show signs of spreading into surrounding fields, and frequently small open areas become surrounded by the advancing forest. Such young forest covers about 9 percent of the area of the flood plain. 4. The older forests cover 40 percent, which is more than any other type of vegetation. These forests mostly consist of rather evenly spaced trees that are most commonly between 12 and 24 inches in diameter. There is typically a continuous canopy, but in contrast with many of the younger forests, enough light penetrates to permit the growth of well-developed shrub and herb layers. 5. Marshes occupy about 4 percent of the area of the flood plain. They are places where standing water is present most or all of the year and tree growth is inhibited. The marshes support typical wetland vegetation, but the composition varies strikingly from one area to another. In addition to the marshes mapped, there is a narrow band of marsh on the east margin of the flood plain, sometimes only a few yards wide, which runs immediately adjacent to the canal bank for much of its length.

The vegetation map is marked in one half mile segments successively from the confluence of the Raritan to Lake Carnegie (fig. 1). These marks serve as reference points in the following dsecription:

FIG. 1. The floodplain of the Millstone River between Lake Carnegie and the confluence of the Raritan showing location of agricultural land (blank spaces), abandoned fields (vertical dashes), young wooded areas (light dots), older wooded areas (heavy dots), and marsh (solid black). Mapping is continuous progressing upstream from the upper left hand corner to the lower right.

1. Agricultural land: There are only three fields on the flood plain which are presently under cultivation. As these fields (near miles .5, 1.0, and 3.5) are higher than the average level of the flood plain, flooding is less frequent and of shorter duration. The remainder of the land under agricultural use consists of pasture, most of which is located on the west side of the river. A typical pasture extends from the road along the edge of the flood plain to the river. The river is bordered by large trees, principally of river birch (*Betula nigra*), silver maple (*Acer saccharinum*), shagbark hickory (*Carya ovata*), pin oak (*Quercus palustris*), black gum (*Nyssa sylvatica*) and others. Large trees, several feet in diameter, are frequently widely scattered over the pasture. A pin oak 63 inchs in diameter, located in a pasture near mile 4.5 on the west side of the river, is the largest tree encountered in the study. Compact hawthorns (*Crataegus sp.*) are usually scattered about and are not severely browsed as are other trees. Young trees of other species may sometimes be seen growing up through the hawthorns apparently protected by them. It is probable that some of the large open-grown trees scattered about became established in this manner. Away from the river bank the flood plain is usually somewhat lower, and drainage is poorer. These lower spots are marshy and contain *Juncus effusus* or several species of *Polygonum* such as *Polygonum hydropiper*, *P. persicaria*, and *P. pensylvanicum* as well as numerous other wetland species.

2. Old fields or areas on which agricultural practices have ceased: Areas abandoned to natural revegetation are mapped as abandoned fields. On former pastured areas the pasture grasses, especially *Agrostis alba* and *Poa pratensis*, form a dense sod that is being invaded by biennial and perennial herbs including *Vernonia noveboracensis*, *Solanum carolinense*, *Aster simplex*, *A. vimineus*, *Solidago nemoralis*, *S. rugosa*, *S. graminifolia*, and *Rumex crispus*. Other herbaceous species often appearing are: *Commelina communis*, *Erigeron annuus*, *Achillea millefolium*, *Agrimonia gryposepela*, *Anthemis arvensis*, *Cirsium vulgare*, *Daucus carota*, and *Linaria vulgaris*.

Considerable variation exists in the prominent species of different abandoned fields depending in part on the last form of agricultural use and the extent of local differences in recent deposition of river alluvium. An abandoned field near the confluence with the Raritan River is dominated by reed canary grass (*Phalaris arundinacea*), a species uncommon elsewhere on the flood plain. A field near mile 7 is dominated by ironweed (*Vernonia noveboracensis*). A portion of a field near mile 1 with a recent silt deposit originating from an area of housing development was completely dominated by a dense stand of ragweed (*Ambrosia trifida*) which attained a height of 14 feet.

Invasion of the abandoned fields by woody species occurs almost concurrently with the invasion by the herbaceous species, and in some fields

woody species have come in first. For example, the edges of some fields are often thick with ash (*Fraxinus americana*) or silver maple seedlings. Large scattered trees in most fields, trees of neighboring forests, and rows of trees along the river form an abundant and nearby seed source.

In addition to the rapidly invading tree species, many shrubs become established in abandoned fields. Blackberry (*Rubus allegheniensis*) elderberry (*Sambucus canadensis*), multiflora rose (*Rosa multiflora*), and silky dogwood (*Cornus amomum*) occasionally form dense stands.

3. The young forest: Thicket type of forest commonly develops from the abandoned field stage, as the many tree seedlings grow into dense stands and shade out the other vegetation. The thicket growth characteristically

FIG. 2. A remnant of an old field that has become surrounded by the young forest. The field is covered with a dense stand of goldenrod.

consists of silver maple with varying amounts of ash, and, in poorly drained places, of pin oak or red maple (*Acer rubrum*). Near mile 10 in an area between the canal and the river, river birch is the thicket former and has produced the only stand of river birch on the flood plain. As the thickets grow up, small glades or openings remain within or between them. These are occupied by dense, rank growth of large herbs including asters, goldenrods and polygonums (fig. 2).

There are some open forests that consist of mixtures of many species of trees scattered or clumped, with dense stands of shrubs, herbs, or vines between them. Near mile 3 on the east side of the river there is one such place where there are many ailanthus trees (*Ailanthus altissima*), honey

locust (*Gleditsia triacanthus*), pin oak, apple (*Pyrus malus*) and hawthorn, as well as the previously mentioned species. Poison ivy (*Rhus radicans*), Japanese honeysuckle (*Lonicera japonica*), wild grapevine (*Vitis vulpina*), catbrier (*Smilax rotundifolia*) and the herbs and shrubs common in the abandoned fields form a dense undergrowth between the trees. This situation is not uncommon. The succession to a closed forest is apparently slowed considerably in such areas, the vegetation remaining a mosaic of clumps of individuals of older trees with openings between them. One such area near mile 3 is especially interesting since wild grapevine has completely covered all vegetation and any young sapling that happens to get started is covered and pulled down by the climbing vine (fig. 3). In the drier areas

FIG. 3. An area near mile 3 where wild grape has become completely dominant over other vegetation even covering large trees.

Osage orange (*Maclura pomifera*), American hornbeam (*Carpinus caroliniana*), slippery and American elm (*Ulmus rubra* and *U. americana*), shagbark hickory, swamp white oak (*Quercus bicolor*) and wild black cherry (*Prunus serotina*) are found scattered but do not form dense stands. As the woodlands become older, dead and dying apple and hawthorn overtopped by other trees can be found. Herbs such as *Geum canadense, Leersia virginica, Oxalis europaea, Lysimachia nummularia, Pilea pumila, Boehmeria cylindrica, Laportea canadensis,* and much *Impatiens capensis* grow in the shaded, moist, wooded environment.

4. The older forests: The tree species of major importance in the older forested regions of the flood plain are ash, silver maple and pin oak. Other species are usually scattered, or only occasionally are dominant.

Many of these forest stands contain some trees over 2 feet in diameter. However, the majority of trees in the older forests of the flood plain are between 12 and 24 inches d.b.h. A sampling of seven trees, varying from 13 to 24 inches d.b.h., in two representative stands ranged in age from 31 to 73 years. All but one of these trees grew at a rate between .37 and .47 inch per year. Thus nearly all of the forested areas of the flood plain date from about 1885 or more recently, most of them in fact having started since 1900.

The most important shrub of the older forested areas is spicebush. Other shade tolerant shrubs such as *Viburnum dentatum* and *V. acerifolium* occur to a considerably less extent. Vines are quite common. In many places wild grapevines grow to the top of the canopy. Poison ivy often covers the forest floor, where it grows several feet high, but it also climbs up the tree trunks to the canopy level. It grows much more profusely in a strip along the river than farther back on the flood plain. Virginia creeper (*Parthenocissus quinquefolia*) is found in small amounts on trees and on the ground but never assumes much importance. Japanese honeysuckle can often be found, especially in small clearings or where the canopy is thin.

Common herbs of the older forested areas are: *Carex grayii, Glechoma hederacea, Onoclea sensibilis, Impatiens capensis, Lysimachia nummularia, Geum canadense, Cryptotaenia canadensis, Verbena urticifolia, Oxalis europaea, Thalictrum dioicum, Leersia virginica, Pilea pumila Eupatorium perfoliatum, E. maculatum, Cinna arundinacea, Polygonum pensylvanicum, P. hydropiper,* and *P. persicaria.* Common in some areas but not of general distribution are: *Arisaema triphyllum, Lobelia cardinalis, Polygonum virginianum, Polygonatum biflorum,* and *Asarum canadense.* Many of the common springtime forest herbs such as *Claytonia virginica, Erythronium americanum,* and *Viola spp.* are present. *Mertensia virginica* occurs but not commonly.

5. The marshes: The marshes scattered about on the flood plain mostly at a distance from the river vary considerably in flora. For instance, *Hibiscus palustris* fills a marsh near mile 5.5 and is rare elsewhere; *Typha latifolia* is important in only one small area near mile 11. *Cephalanthus occidentalis* is prominent in several marshes but is absent from most. *Peltandra virginica* is common and even dominant in the majority of marshes but is entirely absent from some. *Lemna minor* is usually present in marshes containing *Peltandra virginica.* Some other species common in marshes and low places are: *Iris versicolor, Acorus calamus, Nuphar advena, Scirpus rubrotinctus,* and *Cicuta maculata.* Many marshes do not have well defined borders and gradually get moister near the center. The outermost parts are sometimes bordered by *Alnus serrulata* or *Salix nigra.* A dense growth of *Polygonum sagittatum* and *P. arifolium* mixed with *Leersia oryzoides* frequently surrounds the marsh and sometimes *Eleocharis*

palustris or *Asclepias incarnata* are found there. In the winter when the herbaceous vegetation is dead above the ground and the water table is high most of the marsh areas have the appearance of shallow, weedy lakes, but in summer the water is usually well hidden by the rank vegetation.

Discussion. It is evident from this study that the vegetation of the flood plain of the Millstone River is everywhere in some stage of succession from past agricultural use. Even the oldest forests do not compare in size and development with the most mature forests of the flood plain of the Raritan (Buell and Wistendahl 1955).

The earliest stages of succession are dominated by herbaceous plants. In pastured areas these stages are predominantly of grasses (Lavoie 1957). Plowed land and recent alluvial deposits are first occupied by annuals such as ragweed. Seedlings of trees and shrubs become established during this stage but being small add little to the aspect. Also dicotyledonous perennials such as goldenrods and asters begin rapid development. The trees and shrubs grow rapidly and finally appear as thickets or clumps or as scattered individuals in a sea of rank perennials. Whether they are in thickets, in clumps, or as scattered individuals depends on the mode of dispersal of the species, the seed bed, or possibly local environmental influences such as grazing intensity. In any event, the ultimate growth of the woody plants results in suppression by shading of the herbaceous plants under them. In many places, however, where woody plants don't get started early, the large perennial herbs may develop into such rank growth that seedling development of the woody plants is inhibited. Hence the initial pattern made by woody plant growth in thickets with herb-dominated glades has a tendency to persist (fig. 2). This is a type of development that has been recognized by Egler (1954). Progress of the ligneous vegetation in assuming complete occupancy is effected through overspreading of tree branches, the shade thinning the herbaceous vegetation, or through vegetative clonal growth of the shrubs. Disturbances caused by flooding can change the established pattern. When grapevines are involved the persistence of treeless openings may be further accentuated (fig. 3).

The flood plain of the Millstone River has none of the magnificent forests such as still stand on the flood plain of the Raritan River (Buell and Wistendahl 1955). The nearest approach to such a forest occurs between mile 9.0 and 9.5 near Griggstown. (It is interesting that *Mertensia virginica* occurs there as it does in profusion in the oldest forests along the Raritan.) Another difference between the rivers is that 40% of the Millstone flood plain is wooded while only a very small percent of the Raritan is (Wistendahl 1958).

The variety of trees present in the forests of the Millstone flood plain is appreciably less than in that of the Raritan. *Fagus grandifolia, Lirio-*

dendron tulipifera, Tilia americana, Carya cordiformis, Juglans nigra, J. cinerea, Quercus rubra and *Acer saccharum,* common on the Raritan flood plain, are rare on the Millstone. *Platanus occidentalis,* frequent along the Raritan, occurs only occasionally along the Millstone. There is no immediately obvious explanation for these conspicuous differences. It is, however, possible that because the Millstone river flood plain and its environs were completely and intensively used agriculturally there has been an appreciable impoverishment of its flora.

SUMMARY

1. The Millstone River flood plain has been intensively farmed in the past. Thirty-three percent of it is still in agricultural use. Fourteen percent has been recently abandoned from agricultural use and is occupied by a matrix of herbaceous vegetation with thickets, clumps, or scattered individuals of woody plants. Forty-nine percent is now occupied by woodland and 4 percent by marshes.

2. Natural revegetation of agricultural land after farming ceases is rapid. Rank perennial herbs may, however, inhibit the establishment of woody plants so that wherever trees or shrubs do not become established at first, early herbaceous glades may persist for a long time—until shaded out by spreading branches of trees or by vegetative clonal spread of shrubs.

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Literature Cited

Bard, G. E. 1952. Secondary succession on the Piedmont of New Jersey. Ecol. Monogr. 22: 195–215.

Buell, M. F. & Wistendahl, W. A. 1955. Flood plain forests of the Raritan River. Bull. Torrey Club 82: 463–472.

Egler, F. E. 1954. Vegetation science concepts I. initial floristic composition, a factor in old-field vegetation development. Vegetatio 4: 412–417.

Fernald, M. L. 1950. Gray's Manual of Botany, 8th ed. American Book Co.

Lavoie, Victorin, 1957. Etude descriptive de la végétation en plaine de débordement. Rivière Millstone, Millstone, N. J. Manuscript thesis, Faculte des Sciences, Universite de Montreal.

Lewis, J. V. & Kummel, H. B. 1940. The geology of New Jersey, N. J. Dept. Conservation and Development 50 (Geologic series).

Quakenbush, G. A. & Tedrow, J. C. F. 1954. Land type area map of New Jersey. N. J. Agricultural Experiment Station.

Vermeule, C. C. & Smock, J. C. 1894. Atlas of New Jersey. U. S. Geological Survey. New Brunswick, N. J.

Wistendahl, W. A. 1958. The flood plain of the Raritan River, New Jersey. Ecol. Monogr. 28: 129–153.

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PRESENT BIOLOGICAL STATUS OF GEOCARPON MINIMUM MACKENZIE

JULIAN A. STEYERMARK, JOHN W. VOIGT, AND ROBERT H. MOHLENBROCK

The present paper is an attempt to bring together the available information concerning *Geocarpon minimum* Mackenzie which has come to light as a result of continued studies and exploration since the last report by the senior author (1958). Then it was predicted that with the more intensive exploration of sandstone areas of topographic expression similar to those where this rare species had already been found, new stations would be found eventually, particularly if the search was conducted between early April and early May.

Field studies in Missouri. In order to follow up this prediction, the authors on May 3, 1958 visited a number of localities in the unglaciated section of southwestern Missouri situated between the two stations already known in Jasper County (type locality) and St. Clair County. The selection of these localities was based partly on the knowledge of the location of sandstone areas previously visited by the senior author at other times of the year and partly on the study of the latest geological and topographical maps of Missouri for that section of the state. Where certain species of plants appear to be intimately associated with soils of certain lithologic derivation and acidity, the use of such maps for purposes of critical exploration is invaluable and well-nigh indispensable. Study of the geological map revealed the fact that the sandstone formations, previously thought to have been of Pennsylvanian age on the outcrops where *Geocarpon* was discovered, are instead formations of Upper Mississippian age belonging to the Chester series or near the contact zones of the Upper Mississippian with Lower Pennsylvanian (Cherokee) or Upper Ordovician (Jefferson City) rocks. Altogether six stations were visited in the search for *Geocarpon* on May 3, 1958. Two stops were made in Polk County, two in Cedar County, and one each in Greene County and Dade County. *Geocarpon* was found at two of these stations, as follows:

POLK COUNTY. An area predominantly wooded with *Quercus marilandica, Q. stellata,* and *Carya texana* was situated about ¾ of a mile north-northeast of Graydon Springs, and consisted of open sandstone glade areas, 20 to 50 feet wide, which extended north and south along a west-facing slope and minor bluff escarpment bordering a stream tributary to Little Sac River. Here the *Geocarpon* was associated with species of moss belonging to the genera *Polytrichum* and *Grimmia* and was found growing repeatedly in small, moist depressions on the sandstone over several square meters of

the glade where the soil was thin and fine. The moss mats were often thin or broken with the *Geocarpon* occurring in the thin and broken areas. The soil reaction tested about pH 5.0. Other plants found here associated with *Geocarpon* were: *Isoetes butleri, Talinum parviflorum, Sagina decumbens, Arenaria patula, Cardamine parviflora* var. *arenicola, Myosotis verna, Veronica peregrina, V. arvensis, Plantago pusilla, Houstonia minima,* and *Krigia virginica.* In the drier thin soil areas surrounding the glade were *Selenia aurea, Saxifraga texana, Oxalis violacea,* and *Collinsia violacea.* The data for the *Geocarpon* collection are: west-facing sandstone escarpment bordering Coates Branch, tributary of Little Sac River, T 32 N, R 23 W, NW ¼ sec. 31, ¾ mi. NNE of Graydon Springs, Polk Co., May 3, 1958, *Steyermark, Voigt, & Mohlenbrock 86071* (specimens deposited in the herbaria of Southern Illinois University, University of Missouri, and Harvard University).

GREENE COUNTY. A sandstone outeropping of Upper Mississippian age in contact with a Cherokee formation of Lower Pennsylvanian age was situated along highway 123, T 30 N, R 23 W, SE ¼ sec. 8, southeast of Walnut Grove, near Pearl. This was dominated by an abundance of *Selenia aurea, Saxifraga texana,* and *Collinsia violacea,* species previously found associated with the *Geocarpon* in Polk County, and, in the minds of the authors, presumed to have some possible indicator significance for the presence of *Geocarpon.* The first outcrops searched between the highway and adjacent railroad tracks proved unproductive for *Geocarpon.* But a few yards away, in a wooded section beyond the railroad tracks, another area of open sandstone outcropped with a gentle slope to the west. Here, where a trickle of seepage water ran slowly along a shallow drainage through mats of moss and depressions of the sandstone, *Geocarpon* was found in abundance, occurring in a continuous band. Its associates were *Isoetes butleri, Poa chapmaniana, Agrostis elliottiana, Scleranthus annuus* (previously unreported from Missouri), *Talinum parviflorum, Veronica arvensis, Plantago pusilla,* and *Houstonia minima.* It should be noted that some of the associated species at this station as well as at the one in Polk County are of European introduction. The data for the *Geocarpon* collection are: gentle west-facing slope along highway 123, T 30 N, R 23 W, SE ¼ sec. 8, near Pearl, Greene County, May 3, 1958, *Steyermark, Voigt, & Mohlenbrock 86082* (specimens deposited in the herbaria of Southern Illinois University, University of Missouri, and Harvard University).

Such marked success in locating two new stations for this rare plant in the course of a few hours had provoked the authors with undue confidence that they would continue to find *Geocarpon* on any new sandstone outcrop encountered on the journey. These hopes, however, proved to be based upon false assumptions. Although subsequent stops were made at likely looking,

similar sandstone areas in Dade and Cedar counties, no *Geocarpon* was found, even though some of the same associated species were present which we had come to believe always occurred with *Geocarpon*. One of these localities which failed to produce *Geocarpon* was in Dade County situated along Sinking Creek west of Everton in T 30 N, R 26 W, SW ¼ sec. 13. Here the dominant species on the sandstone consisted of *Isoetes butleri, Selaginella rupestris, Bulbostylis capillaris, Scirpus koilolepis, Nothoscordum bivalve, Selenia aurea, Talinum parviflorum, Sedum nuttallianum, Opuntia compressa* var. *microsperma* (*O. humifusa*), *Spermolepis inermis, Centunculus minimus, Collinsia violacea, Lindernia anagallidea, Plantago pusilla,* and *Specularia leptocarpa.*

A second sandstone locality which failed to produce *Geocarpon* was situated in Cedar County on a flat sandstone glade facing east in T 34 N, R 25 W, SE ¼ sec. 16. Here the dominant species were *Talinum parviflorum, Arenaria patula, Corydalis aurea, Selenia aurea, Crotonopsis elliptica, Centunculus minimus, Plantago pusilla,* and *Houstonia minima.* Previously, a third locality in Polk County, southwest of Bolivar, assumed to have an outcropping of Mississippian sandstone, was searched for *Geocarpon* without success. It harbored on the shallow and moist depressions, in an area being pastured, such dominant species as *Sagina decumbens, Arenaria patula, Sedum pulchellum, Androsace occidentalis,* and *Houstonia minima,* while in the immediate area surrounding were conspicuous herbs of *Selenia aurea* and *Astragalus distortus.*

Field studies in Arkansas. Perhaps more startling than the new Missouri stations reported above was the discovery a few weeks earlier in the same year (on April 11, 1958) by Dr. Dwight Moore of Arkansas A. & M. College of two Arkansas localities for *Geocarpon minimum.* Specimens were sent the senior author for verification, and a report published by Dr. Moore in Proc. Ark. Acad. Sci. XII: 12. Oct. 1958. The Arkansas plants were found on a flat, sandy-clay "prairie" area about 5 mi. SE of Warren, T 13 S, R 9 W, SE ¼ sec. 13 and NE ¼ sec. 21, Bradley County, *Moore 58.31,* and in an adjacent area, T 13 S, R 8 W, SW ¼ sec. 18 and NW ¼ sec. 19, Drew County, *Moore 58.32.* Dr. Moore estimates that their area of occurrence in Arkansas occupies approximately a half-mile in diameter (fig. 1). A geological map shows the Arkansas stations as located on deposits of Quaternary Age of alluvium (silt and clay) and terrace sediments, overlain at most places by sand and gravel. These formations are the two most recent ones of the Coastal Plain.

A perusal of the maps and data presented in table 1 showing the Arkansas and Missouri stations (fig. 2) for *Geocarpon minimum* indicates a gap of about three hundred miles separating the Arkansas stations from the nearest Missouri localities. Since sandy soil is apparently the only feature

FIG. 1. Present known range of *Geocarpon minimum* in Arkansas

held in common at all the *Geocarpon* stations, the difference existing in geological age between the Quaternary Arkansas localities and the Upper Mississippian Missouri areas suggests a wide ecological amplitude with the

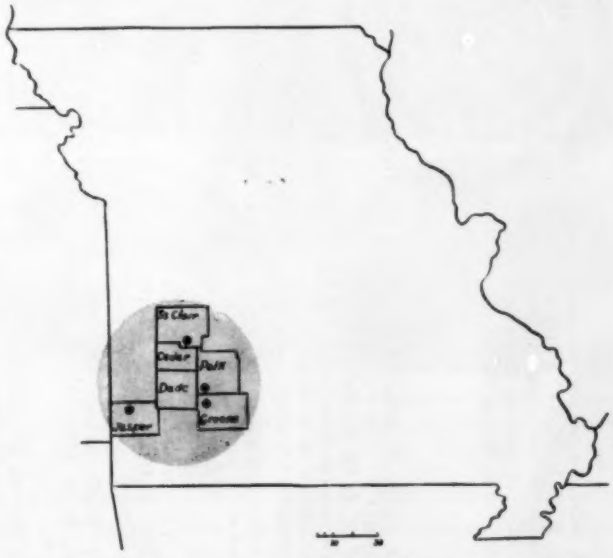

FIG. 2. Present known range of *Georcarpon minimum* in Missouri

TABLE 1. *Summary of known stations for* Geocarpon minimum *in Arkansas and Missouri, with data concerning elevation, slope aspect, and geological relation.*

Stations	Collections	Elevation	Slope Aspect	Geology
Near Alba, *Jasper Co.*, Missouri. R 32 W, T 30 N, SW ¼ Sec. 35, 3½ miles N. of Alba between tributary of Spring River and North Fork, Spring River.	E. J. Palmer 3921 (type) April 20, 1913. E. J. Palmer 5517 May 7, 1914. ——— 48567 April 17, 1949. ——— 48625 May 17, 1949. J. A. Steyermark 67200 April 17, 1949.	850 feet		Sandstone of Chester series of Upper Mississippian
Near Cobb, *St. Clair Co.*, Missouri. T 37 N, R 26 W, SW¼ of Sec. 36, on seepage lines to tributary valley which is a tributary to Rattlesnake branch.	J. A. Steyermark 83775 April 24, 1957.	840 feet	southeast-facing, gentle	Contact of Mississippian sandstone and Jefferson City formation of Beekmantown series of mid-Ordovician.
Near Graydon Springs, *Polk Co.*, Missouri. T 32 N, R 23 W, NW¼ of Sec. 31, ¾ of a mile N, NE of Graydon Springs bordering Coates Branch, a tributary of Little Sac River.	J. A. Steyermark, J. Voigt, & R. Mohlenbrock 86071 May 3, 1958.	1,000 feet	west-facing, gentle	Upper Mississippian sandstone in a contact area of Mississippian with the Jefferson City formation (Ordovician).
Near Pearl, *Greene Co.*, Missouri. T 30 N, R 23 W, SE¼ Sec. 8.	J. A. Steyermark, J. Voigt, & R. Mohlenbrock 86082 May 3, 1958.	1,140 feet	west-facing, gentle	Upper Mississippian sandstone in a contact area of Cherokee formation (Pennsylvanian).
Near Warren, *Bradley Co.*, Ark. Near Monticello, *Drew Co.*, Ark. Warren Prairie between Monticello and Warren, Arkansas.	Prof. Dwight Moore April 11, 1958.	200–300 feet?	Slope Aspect?	Quaternary, Alluvium; sand and gravel.

probability that a wider range of habitat can be endured, thus extending the possible geographical range into the neighboring states of northeastern Oklahoma, southeastern Kansas, and northeastern Texas. Actually, the present range of *Geocarpon minimum* occupies a portion of a pattern of similar range shown by such species associated with *Geocarpon* as *Selenia*

FIG. 3. Upper photograph: habit of *Geocarpon minimum* (× 2). Lower left photograph: seed showing curved embryo within (× 100). Lower right photograph: seed showing papillose surface (× 100).

aurea, Corydalis crystallina, Saxifraga texana, and *Collinsia violacea.* In the case of each of these species, the Missouri stations, as in *Geocarpon,* are restricted either wholly or mainly to the sandstone outcrops of the unglaci-

ated prairie section of southwestern Missouri, while the remainder of the distribution of these species occurs in southeastern Kansas, northeastern and central Oklahoma, northeastern and north-central Texas, and the western and southern portions of Arkansas. The ultimate range of *Geocarpon*, therefore, may eventually be found to have broader limits than those now shown.

Morphological features. Based on observations of living plants, some modifications have been found to exist in our present knowledge concerning details of the gross morphology of the foliage and seeds. The leaves are linear-oblong and either rounded or obtuse at the apex. Some drawings (Gleason 1952) erroneously represent the leaves as acute or acuminate and as growing at the base of the plant in rosette fashion. The eighth edition of Gray's Manual (p. 607) describes the leaves as "ovate to narrowly elliptic," and by Gleason (1952) they are described as "lanceolate to ovate." The plants as a whole often possess a dull wine-purple color. The perianth is pale green, its lower portion frequently being suffused with a vinaceous color. Although the plant is quite diminutive, it has a noticeable succulent aspect (fig. 3). At maturity the entire plant turns an inconspicuous, dull gray-green color.

The seeds have not been described previously in detail. Mackenzie (Torreya 14: 67. 1914) states that they are "minute, smoothish, estrophiolate, the slender, straight, ascending funiculi remaining attached to the five central placentae." In Die Naturlichen Pflanzenfamilien (new ed. Engler-Harms, Band 16 c, p. 233. 1934) the seed is described as "sehr klein, ohne Arillus, mit dünnen geraden, aufsteigenden Funikulus, der an der Plazenta stehen bleibt nach der Ablösung der Samen." The present authors found the seeds to average 320×400 micra, and under a microscope they appear papillose or echinate on the end opposite their attachment to the funicules (fig. 3). The sides of the ovules appear slightly concave and transparent enough to see the curved embryo inside (fig. 3).

Experimental studies. Living plants brought back from the Greene County station were transferred to a control chamber at Southern Illinois University in which the temperature remained 75 degrees Fahrenheit and humidity 70%. Under these conditions and a 13-hour day, *Geocarpon* matured and set seed between May 3 and May 20. The plants at this time became gray-green in color and on May 20 appeared somewhat dry in aspect. Seeds were abundant in the capsules. Future work toward seed germination and other stages in an ecological life history are contemplated by the authors.

SUMMARY

1. New stations for *Geocarpon minimum* were found by the authors in Polk and Greene counties, Missouri, on May 3, 1958, and fulfilled an earlier

prediction made that intensive collecting of sandstone areas in very early spring would reveal new localities between the two previous ones known from Jasper and St. Clair counties.

2. The areas of occurrence in Missouri are all on sandstone formations of Upper Mississippian age belonging to the Chester series and near the contact zone of the Upper Mississippian with either the Lower Pennsylvanian (Cherokee) or Upper Ordovician (Jefferson City) strata.

3. Other localities in Missouri of similar topographic and lithologic expression which failed to produce *Geocarpon* indicate spotty and chance distribution in the geographical range.

4. *Geocarpon minimum* was found in Arkansas on April 11, 1958, at two localities (Bradley and Drew counties) by Dr. Dwight Moore, thus extending the known geographical range of the species southeastward approximately three hundred miles.

5. The greater ecological limits, both in geological horizons and soil expressions, suggest broader geographical range possibilities into adjacent sections of neighboring states.

6. Based on recent studies of living plants, some modifications and new details concerning leaf and seed morphology are presented.

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Literature Cited

Engler-Prantl. 1934. Die Naturlichen Pflanzenfamilien, new ed. Band **16 c**: 233.
Fernald, M. L. 1950. Gray's Manual of Botany, 8th ed. 607.
Gleason, H. A. 1952. New Britton and Brown Ill. Fl. **2**: 112–113.
Mackenzie, K. K. 1914. A new genus from Missouri. Torreya **14**: 67.
Moore, Dwight. 1958. New records for the Arkansas Flora. IV. Proc. Ark. Acad. Sci. **12**: 12. Oct.
Steyermark, J. A. 1958. Another station for Geocarpon minimum. Bull. Torrey Club **85**: 124–127.

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THE AXILLARY BUDS OF GOSSYPIUM[1]

JACK R. MAUNEY AND ERNEST BALL

In the axil of each leaf of *Gossypium* there are found at least two axillary branch buds. One of the buds (fig. 1) lies near the center of the

FIG. 1. Young node of *Gossypium*. Lf = leaf scar; S = stipules; A_1 = first axillary (Cook's extra-axillary position); P_1 = prophyll of first axillary; A_2 = second axillary (Cook's axillary position). Magnification: approx. 3×.

region of leaf attachment. The other develops off to the side of the leaf axil. Approximately half of these off-center buds are to the right and half to the left of the central bud. In addition, cotton has two types of branches, monopodial vegetative branches and sympodial fruiting branches (Gore 1935). The relationship of these buds to each other and to the stem and their function in producing the two branch types has been of interest to many investigators in the past half century. The classic works of Cook (1911) and Cook and Meade (1911) founded the nomenclature which has been used with variation by most other workers. Principally on grounds of position, they termed the center bud "axillary," the off-center one, "extra-axillary." They observed that at the lower nodes of the plant, vegetative branches might develop from either of the two buds, but they

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never observed fruiting branches, which grow from the higher nodes, developing from any but the off-center, "extra-axillary," position. Though they had observed vegetative branches developing from both the bud positions, Cook and Meade did not believe that a true vegetative "limb" could develop from any but the "axillary" position. They viewed the development of vegetative forms from the "extra-axillary" position as some sort of transformation from its normal function. They stated: "The differences of origin and position enable two kinds of vegetative branches to be distinguished, the true axillary limbs and the vegetative branches which arise from extra-axillary buds. Though both kinds of vegetative branches have the same appearance and function, it is desirable to recognize the difference of arrangement because the extra-axillary vegetative branches often replace the fruiting branches, to the serious detriment of the crop."

The terminology of Cook has been widely used by later workers and reviewers (King 1930, Templeton 1929, Hayward 1938, Eaton 1955) with the exception that Templeton substituted the term "accessory" for "extra-axillary." Gore (1935) and Hector (1936) pointed out, however, that the centrally located bud is usually dormant, and the latter author (p. 842) referred to it as the "accessory" bud, "Since it owes its origin to the fact that the original axillary bud primordium has by branching given rise to an extra bud or buds."

To complicate matters further, several writers (Templeton 1929, Hayward 1938, Eaton 1955) held to Cook's terminology but extended his position-function observations to the point of attributing to the two buds fundamentally different roles in the branching of the plant. They gave the impression that all vegetative branching occurs via development of the "axillary" position while all sympodial branching is through development of the "extra-axillary" position. Eaton (1955) expressed this point of view most concisely: "Two buds are formed at the base of each leaf. If the axillary bud develops, it produces a vegetative branch. If the extra-axillary bud, which may be located either to the right or to the left of the axillary, develops, it produces a fruiting branch." This view is clearly in conflict with the opinion of Cook and Meade (1911) outlined previously with regard to the vegetative branching of the plant, since they observed vegetative branches from the "extra-axillary" position at lower nodes.

Superficial observations by the present authors of mature plants of the species and varieties maintained in the Raleigh collection showed that the majority of both vegetative and reproductive branches on an axis arise from the bud which occupies the off-center position and which Cook and Meade (1911) termed "extra-axillary" because of its position. Though Eaton (1955) and others attributed to this bud the function of producing flowering branches, it is clear that most of the vegetative branches at the low nodes also arise from it.

The more nearly central bud, on the other hand, was seen to be often dormant, always later in its development than its neighbor, and generally vegetative. On some vigorously flowering plants, flowering branches were observed to develop from this bud at the higher nodes. This tendency to produce flowers from the central axillary bud appears to be, in part at least, under genetic control. Some varieties have many flowers at this position; in others this bud, as noted earlier, is always vegetative and usually dormant.

It is the purpose of this paper to attempt clarification of these conflicting reports through presentation of new evidence concerning the relationship of these axillary structures and to suggest a new terminology to facilitate discussion of this relationship.

Materials and methods. *Gossypium hirsutum* var. Coker 100 W was used for dissection and cross-sectioning in this study. Nodes from plants having four or five expanded leaves were used for both dissection and serial cross-sections. Dissections were made on fresh tissue under a 9X–54X stereoscopic microscope. Tissue for sectioning was killed in FAE, dehydrated by the tert-butyl alcohol technique, and imbedded in rubberized paraffin. To soften the very hard sclereids found in even very young cotton stems the embedded tissue was allowed to stand in a hydrofluoric acid solution for several weeks before slicing. The tissue was sectioned at 10μ, stained in safranin, and counter-stained with fast green.

Observations. Dissections of successive nodes from the terminal meristem to the cotyledons showed that the bud which occupies an off-center position on a mature node develops from the first shoot apex to arise in the axil of each leaf. In its early development this off-center bud occupies a very nearly central position in the leaf axil, but for reasons which are not entirely clear it grows progressively more off-center as it develops. This bud is responsible for the majority of both vegetative and reproductive branches on the cotton plant, and is indicated in figures 1–7 as having already produced a stem, labeled A_1. At low nodes it is vegetative; at higher nodes it is reproductive. Because this bud is the first to appear, and in recognition of its dominant role in the branching of the plant, the present writers suggest the term *first axillary* for it. The term *second axillary* is then used to refer to the smaller bud, labeled A_2 in the figures, which is apparently centrally located with respect to the axillant leaf (see fig. 1). This terminology is followed in the remainder of this paper.

The position of the first axillary with respect to the second is generally determined by the phyllotaxy of the plant. If the plant has a right-hand phyllotaxy, that is, each leaf is $\frac{3}{8}$ turns to the right above the preceding leaf, then the first axillary is usually to the right of the second. The plants in figures 1–7 had left-hand phyllotaxies; a reverse orientation of the

axillary structures is found in plants with a right-hand phyllotaxy. As can be seen in figure 1 the second axillary is also slightly displaced toward the opposite side of center from the first. This is usually the case.

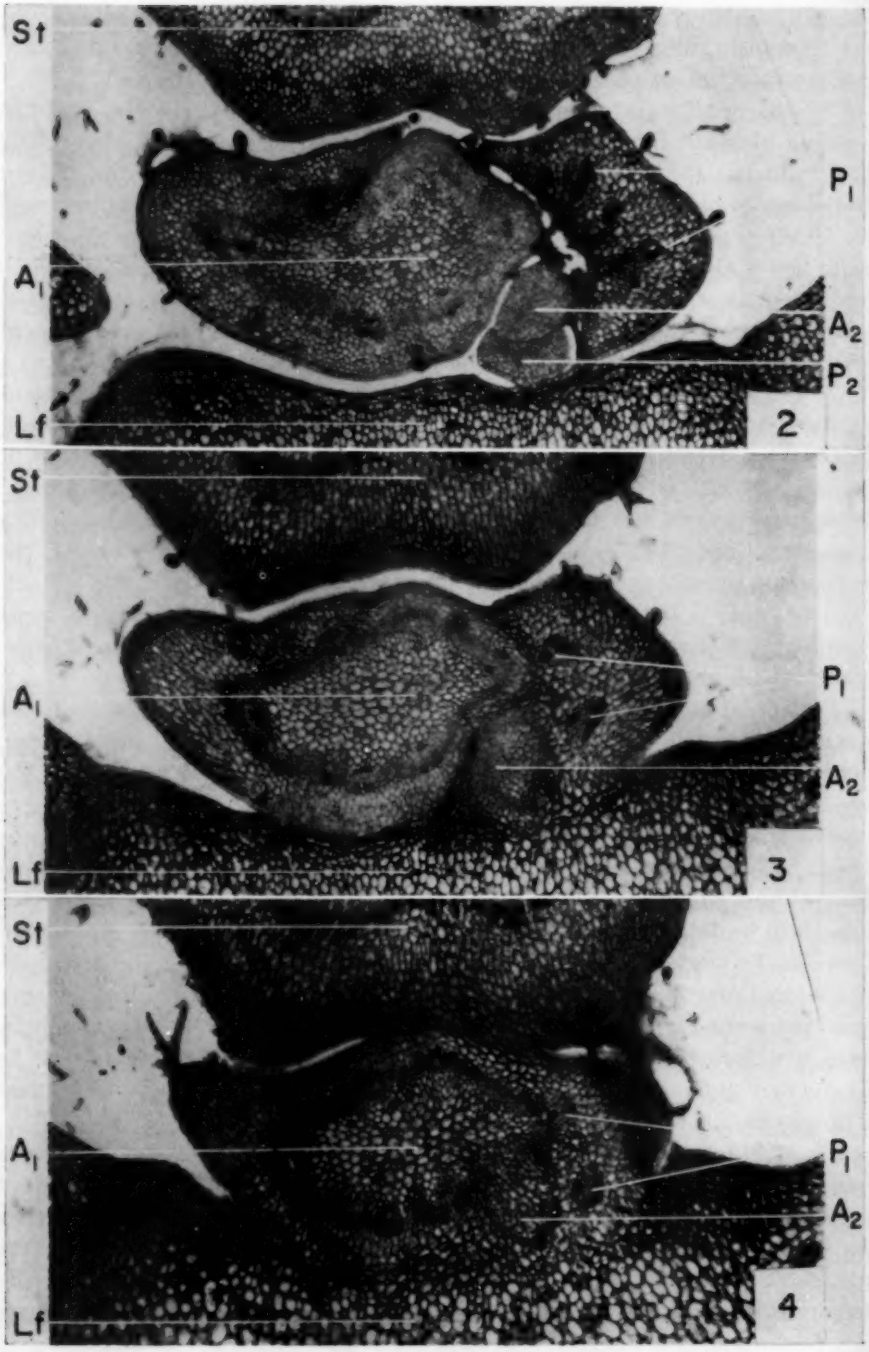
The correlation between the spiral arrangement of the leaves and the position of the axillaries is not exact, however. An examination of field plants during the 1958 season showed that on approximately 5 per cent of the nodes observed the position relation of the two buds was reversed from that expected from the phyllotaxy of the plant. Virtually every plant examined had at least one node on the primary or branch axes on which this reversal was evident. It was also found that no correlation exists between the position of the buds and direction of the spiral arrangement of leaves on the branches which developed therefrom.

A third structure which has received little attention from previous workers is associated with these axillary buds. This structure is a bract-like leaf unattended by stipules which occupies a position on the side of the second axillary opposite the first (P_1 in fig. 1). Very rarely this leaf develops a petiole, but usually it is strap-shaped, looking very much like a stipule. Gore (1935) includes this structure in his description of the development of the sympodial branches of cotton. He associated this "bract-like structure" with what he termed the "axillary-bud" which rests between each flower and its attendant leaf. This bud seems to be comparable with the second axillary described here.

Dissection of young nodes near the apex of the plant showed that this structure develops much earlier than the second axillary primordium. Consequently, it appears that this strap-shaped leaf is an offshoot of the first axillary rather than the second.

The structure seems to be comparable with the prophylls of other genera (Esau 1953, p. 412), though it is not paired as is commonly the case in the dicotyledons. However, in the terminology of Troll (1954, p. 125–140) this structure would be termed a prophyll even though it arises singly. In *Capsella, Fragaria,* and *Crataegus* only one prophyll arises at the first node of the axillary branch. In these cases Troll interprets the leaf arising from the second node of the branch to be the second prophyll, though in some it differs in appearance from the first prophyll. With this work as a precedent the strap-shaped structure in cotton will henceforth be termed a prophyll.

To elucidate the relationship of these three structures further, cross sections were made through nodes of various ages. Figures 2 through 6 show sections taken at various levels in a typical node. It can be seen that the vascular system of the second axillary branches from that of the first and that it emerges through the same gap as one of the traces for the prophyll. It seems clear then, that the stipule-like leaf is indeed a prophyll


St
P1
A1
A2
P2
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St
P1
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Lf
3
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P1
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Lf
4

of the first axillary and that the second axillary is the bud which arises in its axil.

As can be seen from inspection of figures 2 to 4 the second axillary is not centered in the axil of the prophyll. This condition is generally found and may be a manifestation of the general off-center positioning of axillaries in cotton. On the other hand, the apparent position of the second axillary may arise from the prophyll being developed in a one-sided manner (notice P_1 in fig. 2). This prophyll commonly has only two principal vascular traces (P_1 in fig. 3) while the major leaves have three. However, though this off-centered condition is perplexing, the basic relationship of the second axillary as the branch bud in the axil of the prophyll seems established.

Observations of nodes on vigorous field-grown plants on which both the first and second axillary developed into branches showed that the prophyll of the second axillary (P_2, figs. 2 and 7) is similar in appearance to that of the first axillary. In its axil a third axillary develops and is seen on many plants observed in the field (fig. 7).

Discussion. The key concept in the theory of axillary bud relationships outlined here is that the second axillary branches from the first, the third branches from the second, etc. The fact that no internode occurs between the junction of the first axillary with the stem and its first node causes the second axillary to nestle at its base. This telescoping of nodes and the inconspicuous nature of the prophyll at this first node have made identification of the second axillary as a branch of the first more difficult.

In the passage quoted previously, Hector (1936) outlined without emphasis the same relationship proposed here. He recognized that the second axillary was a branch of the first and that the first axillary had the dominant role in the branching development of the plant. However, he failed to note the prophyll and relate it to the other axillary structures.

Branching by means of axillary buds in the axils of prophylls occurs in several genera. Troll (1954) reported branching by means of prophyll axillaries in *Fragaria, Salix,* and *Crataegus.* Branching by means of prophyll axillaries is particularly important in *Fragaria* since these branches are the principle means by which the stolons are extended.

The occurrence of a third axillary bearing the same positional relationship to the second that the second bears to the first is readily predictable from this theory of branching. The fact that the third axillary has been

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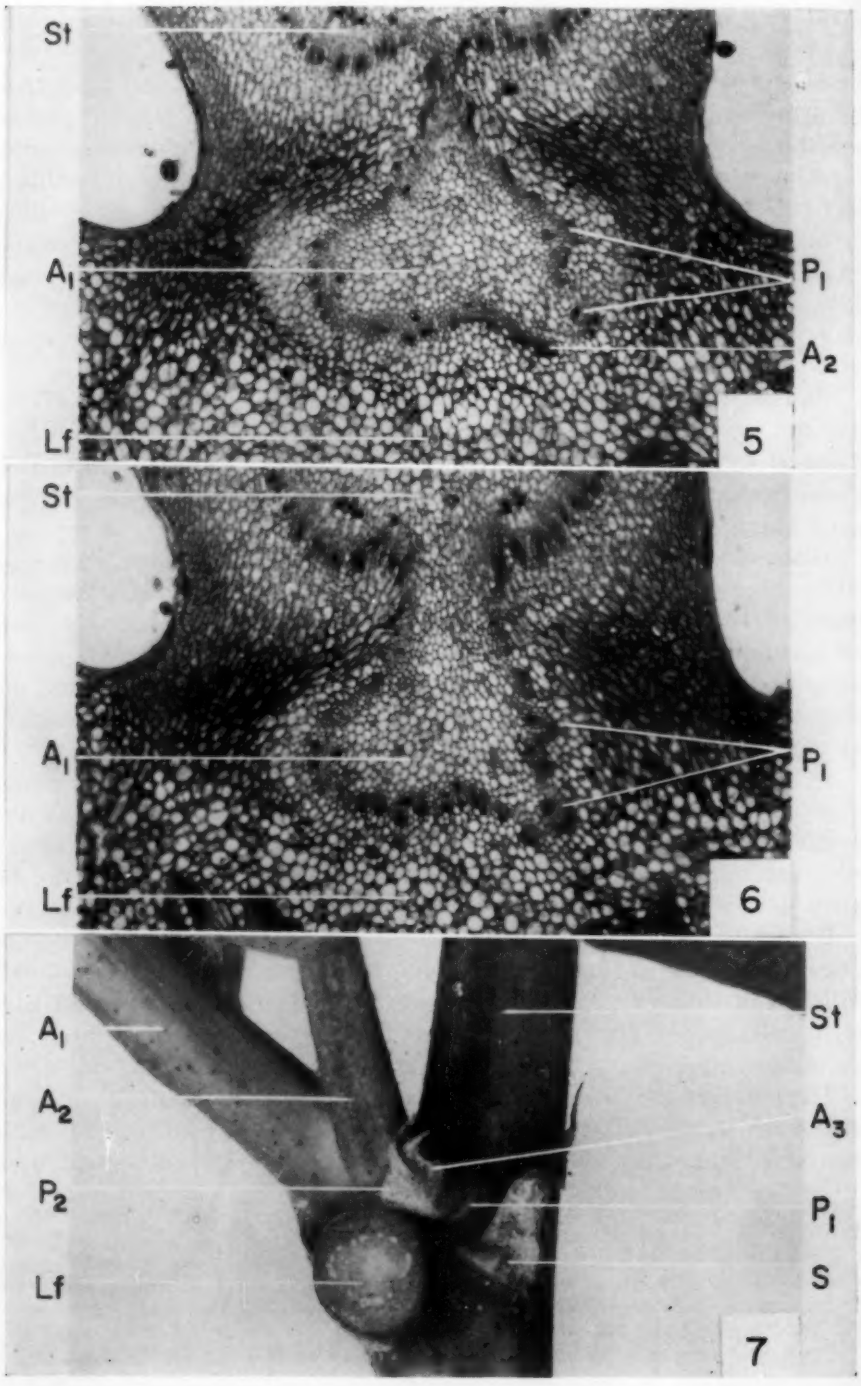
FIG. 2–6. Cross sections at various levels in a *Gossypium* node. St = primary stem; Lf = subtending leaf; A_1 = first axillary axis; A_2 = second axillary axis; P_1 = prophyll of first axillary (the two positions indicate two of the vascular traces); P_2 = prophyll of second axillary. Magnification: 66×. FIG. 2 is a section approximately 20μ below the meristem of the second axillary. FIG. 3 is 30μ below 2; FIG. 4 is 30μ below 3; FIG. 5 is 30μ below 4; FIG. 6 is 30μ below 5.


St
A1
P1
A2
Lf
5
St
A1
P1
Lf
6
A1
A2
P2
Lf
St
A3
P1
S
7

observed on many plants in the expected position tends to confirm this theory. Fourth and fifth axillaries may be expected to occur on plants which are cut back or grow for extended periods, and in fact green-house plants which are pruned do indeed develop new branches from positions predicted by this theory.

The reason for the off-center position of the axis of the first axillary is not readily apparent. In the early stages of development it is very nearly central, and when the displacement of its prophyll is taken into account the axis can be interpreted as arising from the center of the leaf trace. Still, the forces are obscure which push it further off-center as it develops. Since the axis of the first axillary is usually on the side of the leaf trace nearest the next higher leaf on the stem, there is a temptation to attribute its drift away from center to the spiralling development of the stem. However, on the small percentage of nodes on which the first axillary develops on the side away from the next higher leaf its axis is just as much off-center as in the more common instances. Consequently, the correlation between off-center drift and spiral development breaks down and the causes of this peculiar placement of the first axillary remain obscure.

The analysis of the branch bud relationships presented in this paper has interesting implications in regard to the relative ability of the buds to produce vegetative and reproductive branches. Though clusters of buds occur because of the failure of internodes to develop, only one axillary develops in the axil of any given leaf or prophyll. Thus each bud primordium must have the same potential for producing the two types of branches. The deciding factor in determining the character of any branch bud then must be associated with the physiological forces impinging upon it during development rather than a fundamental morphological difference between the bud positions. For instance, if the physiological factors which influence a primordium into becoming a floral meristem were localized near the apical meristem of an axis the first axillary would be influenced by them while the second would not, since it develops later, i.e., further away from the apical meristem, than the first. Under certain conditions this zone of "influence" might be broad enough to include the position of the second axillary primordium in which case both first and second axillaries would produce sympodial branches. Under conditions where no such reproductive "influence" existed both positions would be vegetative.

Of course, whether such zones of influence exist and the nature of the influence remain to be studied. It is clear, however, that the branching potential of the bud positions is morphologically equal so that schemes

FIG. 7. Mature node of *Gossypium*. St = primary stem; Lf = leaf scar; S = stipule; A_1 = first axillary axis; P_1 = scar of prophyll of first axillary; A_2 = second axillary axis; P_2 = prophyll of second axillary; A_3 = third axillary. Magnifications; approx. 2×.

other than mere position of the buds must be invented to explain the fact that some nodes bear only vegetative branches, others have a reproductive and a vegetative branch, while some bear two reproductive branches.

SUMMARY

1. A study of axillary branch buds of *Gossypium hirsutum* by dissection and microscopic examination of cross sections shows that the second axillary bud is a branch of the first just as the first is an axillary branch of the primary axis.

2. The small bract-like leaf which accompanies the buds has been shown to be a prophyll of the first axillary. It is in the axil of this inconspicuous structure that the second axillary arises.

3. This interpretation of the bud positions suggests that they are of the same morphological character. Thus, new mechanisms must be conceived to explain why one is often reproductive while the other remains vegetative.

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Literature Cited

Cook, O. F. 1911. Dimorphic branches in tropical crop plants. U. S. Dept. Agr., Bur. Plant Ind.—Bulletin No. 198.

Cook, O. F. & Meade, R. M. 1911. Arrangement of parts in the cotton plant. U. S. Dept. of Agr., Bur. Plant Ind.—Bulletin No. 222.

Eaton, F. M. 1955. The physiology of the cotton plant. Ann. Rev. Plant Phys. **6**: 299–328.

Esau, Katherine. 1953. Plant Anatomy. New York.

Gore, U. R. 1935. Morphogenetic studies on the inflorescence of cotton. Bot. Gaz. **97**: 118–138.

Hayward, H. E. 1938. The structure of economic plants. Chapter XIV. New York.

Hector, J. M. 1936. Introduction to the botany of field crops, **2**: Chap. 19, Central News Agency. Johannesburg, So. Africa.

King, C. J. 1930. Development of axillary buds on fruiting branches of Pima and Upland cotton. Jour. Agr. Res. **41**: 667–714.

Templeton, James. 1929. The branching of Egyptian cotton plants. Ministry of Agriculture, Egypt—Bulletin #87.

Troll, W. T. 1954. Praktische Einführung in die Pflanzenmorphologie. Vol. **1**, Jena.

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A NEW ECHITES FROM MEXICO

JOSEPH MONACHINO

As delimited by Woodson (N. Am. Fl. 29: 173–176. 1938), *Echites* comprises seven species, all native to Mexico and Central America. The type of the genus, *E. umbellata* Jacq., has a relatively broad distribution, being found from southern Florida to the West Indies, Mexico, Central America and Colombia. One of the species, *E. parviflora* Sessé & Mociño, was reported by Woodson (loc. cit. 174) as known only from the type locality, Apatzingan, Michoacan, Mexico. This species was published in 1888, Planta Novae Hispaniae, supp. to La Naturaleza, II, Vol. 1, p. 28. The name is a later homonym of the Indian *E. parviflora* Roxb. described in 1832, Fl. Ind. 2: 20. "*Echites parviflora* Afz." was cited by Ettingshausen in 1861 (Blatt.-skel. Dikot. 72, fig. 35), who described and illustrated the leaf nervation of this unidentified species. (The binomial also duplicates *E. parviflora* Roxb. Hort. Beng. 85. 1813. nom. nud. and *E. parviflora* Afz. ex Steud. Nom. Bot. ed. II, 1: 540. 1840. nom. nud.) The name is therefore illegitimate and must be rejected. The description of the illegitimate *E. parviflora* Sessé & Mociño corresponds closely with the Hinton plant being here described and illustrated. Without seeing the type, however, there may be some doubt and, rather than proposing merely a new name, I choose to describe the plant as a "new species." Its position in a key to the members of the genus falls in with *E. parviflora* in Woodson's treatment (loc. cit. 173); there and elsewhere *E. woodsoniana* should replace Sessé and Mociño's illegitimate name. The epithet of the new species is respectfully intended to honor Robert E. Woodson, Jr., for his reconstitution of the genus *Echites* and for his basic study of both this and other genera of Apocynaceae.

Echites woodsoniana Monachino sp. nov. Frutex scandens glaber, foliis oppositis, petiolis 7–12 mm. longis, laminis foliorum ovatis vel lanceolatis 4–7.5 cm. longis, 2–3.5 cm. latis, ad basin rotundatis vel obtusis, ad apicem breviter acuminatis acutisque, venis lateralibus principalibus ca. 7–10 binis, reticulo inconspicuo; inflorescentiis axillaribus cymosis; floribus usque ad 12 parvis; lobis calycis ovatis vel deltoideis ca. 1 mm. longis; corolla hypocrateriformi, tubo ca. 7–8 mm. longo, extus glabro vel minute puberulo, intus piloso, lobis patentibus lineari-lanceolatis usque ad 2 cm. longis usque ad apicem angustatis, supra hirtello-barbatis; staminibus circa mediam partem tubi corollae insertis, filamentis corollam adnatis, antheris glabris lanceolatis ca. 4 mm. longis; ovario glabro, nectariis 5, glabris, ovario aequilongis; folliculis ca. 25–30 cm. longis, seminibus ca. 8 mm. longis, rostro 5 mm. longo, coma 3 cm. longa.

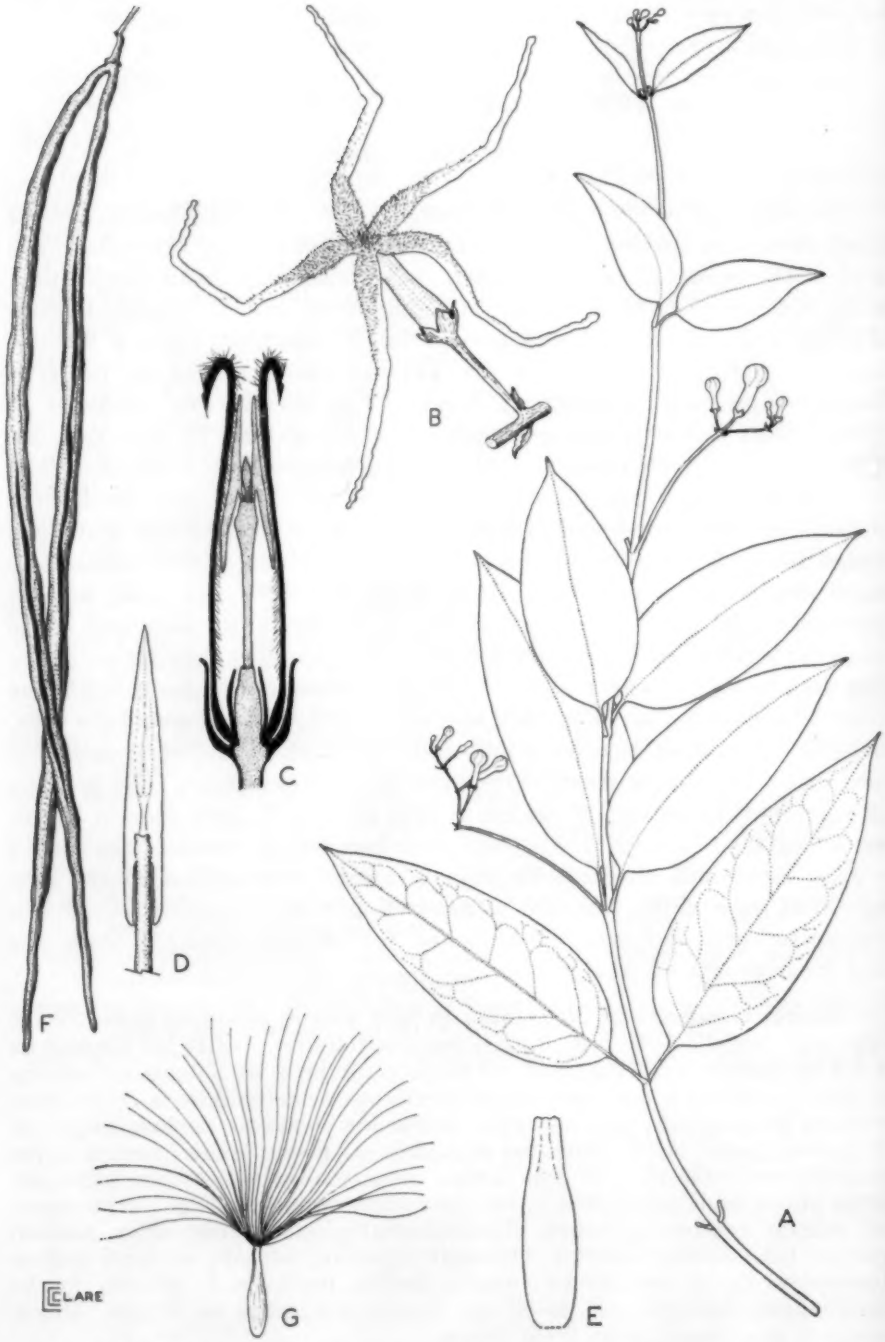

FIG. 1. *Echites woodsoniana* Monachino. A–E, type, Hinton 15325; F & G, paratype, Hinton 7589. A, habit, × ⅔; B, flower habit, × 3.4; C, flower longtitudinal section, × 10; D, stamen, × 14; E, ovary, × 24; F, fruit, × ½; G, seed, × 1.3.

Essentially glabrous vine with milky juice; stem terete. Leaves opposite; axillary glands relatively conspicuous, numerous, linearconic, up to 1 mm. long; petioles 7–12 mm. long, sometimes faintly puberulous; blades chartaceous to subcoriaceous, dull, ovate or lanceolate, 4–7.5 cm. long, 2–3.5 cm. broad, rounded or obtuse at base, short-acuminate and acute at apex, the principal lateral nerves about 7–10 pairs with fainter ones in between, openly spaced, ascending, branching toward margins of leaf, the veinlets inconspicuous. Inflorescence appearing mostly axillary, cymose, the axis forked, sometimes with one or two pairs of leaves at base; flowers small, indefinite in number, up to about a dozen; pedicels up to 4 mm. long; calyx-lobes ovate or deltoid, about 1–1.3 mm. long and as broad at base, acute or obtuse at apex, margins entire or faintly erose; squamellae opposite the calyx-lobes, relatively conspicuous, up to 0.7 mm. long. Corolla salverform; tube 7–8 mm. long, 1.8–2 mm. broad, externally glabrous or faintly and sparsely puberulous, pilose within; lobes spreading at anthesis, linear-lanceolate, variable in length, surpassing the tube when fully developed, about 2 cm. long, 3.3 mm. broad at base, tapering to a fine apex, conspicuously gray hirtellous-barbate on upper surface particularly toward base; in bud the corolla-lobes are dextrose convolute, the long tips compactly infolded so to form a globose head about 4 mm. high. Stamens inserted near middle of corolla-tube; filaments adnate to corolla and appearing as ridges extending to almost the base of tube; anthers glabrous, lanceolate, about 4 mm. long, sagittate at base, tips membranaceous, acute, almost reaching orifice of tube, polleniferous loculi 2 mm. long. Ovary glabrous, conical, about 1.3 mm. long, style 1–1.7 mm., clavuncle 0.7–0.9 mm., apiculi 1 mm. long. Nectaries 5, glabrous, oblong-lanceolate, flattened, scale-like, about length of ovary. Follicles free, slender, 25–30 cm. long, 5–7 mm. thick; seeds numerous, oblong, about 8 mm. long, the beak thickish, about 5 mm. long, the coma light fulvous-brown, about 3 cm. long.

Type: Mexico: Ajuage, Apatzingan, Mich., Oct. 13, 1939, woods, local, *Geo. B. Hinton 15325* (The New York Botanical Garden).

Paratypes: Mexico: Tario, Coyuca, Gro., Apr. 2, 1934, Barranca, *Geo. B. Hinton 5863* (NYBG, Gray); *7589*, loc. cit., Apr. 5, 1935 (NYBG).

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New York 58, N. Y.

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EXPERIMENTAL STUDIES ON GROWTH OF EXCISED GRASS EMBRYOS IN VITRO. II. EFFECT OF MALEIC HYDRAZIDE ON EMBRYO GROWTH

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Since the report by Schoene & Hoffmann (1949) that maleic hydrazide (MH) has an effect on plant growth, considerable data has been accumulated during the past decade on its manifold influence on plant tissues. Zukel (1952–55) has adequately summarised and compiled in the form of abstracts the results of several investigations in this field. With regard to studies on the monocotyledonous plants, Hoagland, Elliot and Rasmussen (1953) have given an account of the histological and morphological effects of MH on a Spring wheat, and Struckermeyer (1953), on Croft Easter lilies. Developmental details of embryos from treated panicles of oat (Mericle, Eunus and Mericle 1955) have shown that high concentrations of MH cause disruption of organogenesis. Recently Gifford (1956) has given details of anatomical and cytological responses of barley subjected to the influence of this unique growth regulant.

Several properties have been attributed to MH as an agent in causing numerous growth effects on plants. Nickell (1952) has rightly observed that all investigations with MH to date, have shown only inhibition of growth with no formative effects on plants. From pertinent literature on the subject, however, it would appear that most experiments under report involving the use of MH have been carried out under field conditions either handsprayed or applied as pastes on the organs concerned. The present investigation was designed to provide an anatomical basis to explain in what way and to what extent the developing embryos excised from the confines of the caryopses respond to varying concentrations of this chemical *in vitro* in order to throw light on the mechanism of its growth-inhibiting action.

Materials and methods. Young caryopses of the cultivated Indian millet, *Pennisetum typhoideum* Rich., strain T-25 were chosen as embryo source for experimental work. Those of *Hordeum vulgare* Linn., *Avena sterilis* var. *culta*, and *Triticum vulgare* Villd. were utilised for comparison. The plants were grown in the Botanical Garden of the University of Delhi from seeds obtained from the Millet Specialist, Coimbatore, India. Embryos of three morphological groups viz. (1) young and in the process of differentiation, (2) differentiated but immature, and (3) nearly mature (Narayana-

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swami, 1959) were dissected out and inoculated on media contained in sterilised vials. Both liquid and agar (1 per cent Difco Bacto agar) were tried using White's modified solution (Narayanaswami 1959) as the basic medium. MH 40, a water-soluble sodium salt supplied by the NBC, Ohio, U.S.A., was used in molar concentrations and the pH was adjusted to 5.5–6.0 before autoclaving. Each treatment consisted of 25 cultures with two embryos in each, and the experiment repeated. Fixations were done in FAA at various intervals as warranted. The customary methods of infiltration, sectioning and staining were followed. Both haematoxylin, and safranin-fast green combinations gave good differentiation.

Observations. Embryos cultured in different concentrations of maleic hydrazide showed a number of anomalous features. An account of the histological responses of such embryos is presented below.

Effect of MH, 1×10^{-2}M. Young differentiating embryos turned brown and died within a week of inoculation. Immature but differentiated embryos incubated for 10 days swelled up considerably but showed no growth either of the coleoptile or the primary root. Necrosis of portions of the scutellum and coleorhiza was evident. Longisections of such embryos showed complete degeneration of the provascular strand supplying the embryonal parts. Embryos of near mature size cultured for over two weeks showed necrosis of the scutellar tissue in immediate contact with the medium. The outer epidermal layer of the rest of the scutellum appeared strongly suberised; the subjacent cells were smaller and arranged in more or less regular radial rows akin to the formation of a periderm. Degenerated remnants of isolated cells were also observed.

Effect of MH, 1×10^{-3}M. Figures 1 and 2 show differentiated but immature embryos of maize and the millet (*Pennisetum*) subjected to the influence of MH, 0.25×10^{-3}M and 1×10^{-3}M respectively for 5 days. In both the plants, elongation of the coleoptile in all the subjects treated indicated some stimulation of growth. The primary root was, however, inhibited and in no case did it ever break through the coleorhiza as compared to those on the control medium in which the root and shoot growth was normal (fig. 3) for the same period of incubation.

In cultures of *Pennisetum* embryos undergoing differentiation, necrosis of the nodal plexus (np) and failure of further differentiation of the root accompanied by a precocious maturation of the scutellar cells (sc) was noted (fig. 4). Collapsed remnants of the root cap (rc) and thickening of the cell walls of the root initials (ri) were observed in a longisection of a young embryo (fig. 5).

Differentiated but immature embryos of wheat cultured for 5 days showed the shoot (s) as well as the root apices (rc) to have been deleteriously affected (fig. 6). Figure 7 is a longitudinal section of an embryo of

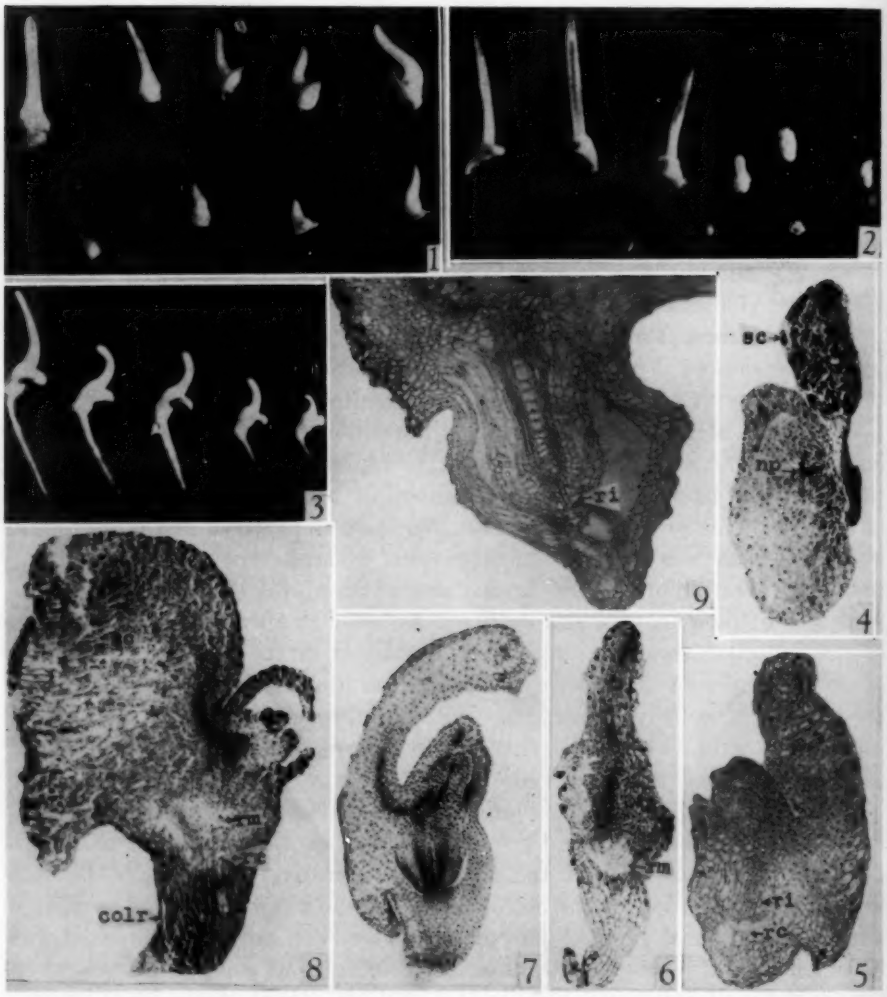


FIG. 1. Maize, immature embryos grown on White's basal medium containing MH (0.25×10^{-3}M) for 5 days; note coleoptilar growth and inhibition of roots. FIG. 2. Barley, immature embryos on MH (1×10^{-3}M) for 5 days. Coleoptilar growth is promoted and root inhibited; younger embryos show no response. FIG. 3. Barley embryos showing normal seedling growth on the control medium. FIG. 4. *Pennisetum*, l.s. young embryo on MH (10^{-3}M) for one week showing necrosis of nodal plexus (np) and precocious maturation of scutellar cells. FIG. 5. Same as above, on MH (10^{-3}M); note collapsed remnants of the root cap (rc) and thickening of the cell walls of root initials (ri). FIG. 6. Wheat, l.s. embryo cultured at differentiating stage on MH (10^{-3}M) for 5 days; both the primary root meristem (rm) and the shoot (s) are vacuolated. FIG. 7. *Pennisetum*, l.s. young immature embryo on the control medium for one week. FIG. 8. Same as above, for two weeks; root cap (rc) and coleorhizal cells (colr) are vertically elongated and scutellar cells, radially. Vacuolation of the cells of the root meristem (rm) is also seen. FIG. 9. Longitudinal section coleorhizal portion of *Pennisetum* embryo of near mature size on MH (10^{-3}M) for 5 days.

Pennisetum of the same age cultured for a week on the control medium which shows normal development without any breakdown of internal tissue.

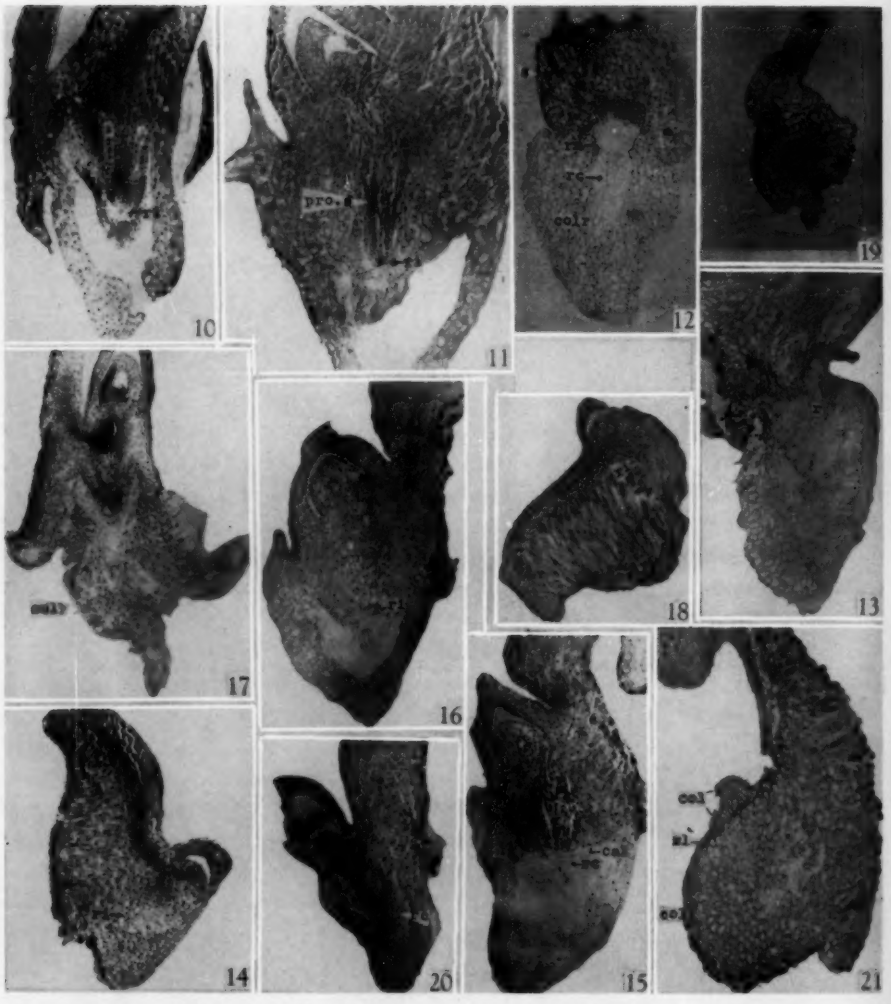
Immature embryos of *Pennisetum* incubated for over two weeks showed a change in their external morphology as a consequence of overgrowth of the scutellum. Longisections of such embryos revealed that the subepidermal cell layers of the scutellum were radially elongated and the cells of the coleorhiza and the root cap, vertically (fig. 8). The root meristem (rm) appeared to have been bleached out *in toto.*

Embryos of near-mature size showed the apical group of root initials to have been adversely affected in that the cells were thick-walled and enucleated (fig. 9, ri). Inhibition of root growth following obliteration of the root initials and their derivatives occurred in such embryos within a week of culture on the test medium (fig. 10). A similar feature was also observed in oat embryos of the same age. The root initials (ri) were necrosed and the procambium showed accelerated maturation into elements developing scalariform or spiral thickenings (fig. 11). Also, the thin-walled cells of the phloem at certain places were in a state of collapse depleted of their contents.

Figure 12 is photomicrograph of a median face longitudinal section of a young wheat embryo in the process of differentiation grown on liquid medium (MH, 10^{-3}M) for 5 days showing hypertrophy of the coleorhizal cells (colr), collapse of the root cap (rc) and vacuolation of the cells of the radicle (r). The same effect was noted in embryos of near mature size in a medium of half the strength of MH (fig. 13). With immature *Pennisetum* embryos, elongation of the scutellar cells and of the root initials (ri) followed by their vacuolation prior to degeneration was observed (fig. 14). Longisections of differentiated but immature oat embryos at culture indicated loss of meristematic potentiality of the root apex within 10 days of inoculation on medium containing MH (0.5×10^{-3}M). Complete degeneration of the root initials (ri), root cap (rc) and the calyptrogen layer occurred in such embryos within 2 weeks in the culture medium (figs. 15, 16). No deleterious effects especially on the root meristem were, however, observed in 10-day old cultures of young immature *Pennisetum* embryos on MH, 10^{-3}M to which IAA, 10^{-4}M was added (fig. 17).

Effect of MH, 1×10^{-4}M. In this concentration cultures of *Pennisetum* embryos in the process of differentiation showed radial elongation of the scutellar cells within a week of inoculation, the root initials having been transformed into permanent cells (fig. 18). In embryos still younger, the cells of the shoot meristem elongated en masse instead of undergoing normal organ differentiation (fig. 19), and no root was ever formed. The entire embryonal tissue presented the appearance of mature cells.

Elongation of the cells of the coleorhiza, the root cap and the root



FIGS. 10–17. Effect of MH (10^{-3}M) and figures 18–21 of MH (10^{-4}M) on embryos. FIG. 10. *Pennisetum*, l.s. embryo of near mature size incubated for one week; the group of root initials (ri) is obliterated. FIG. 11. Oat, l.s. immature embryo incubated for one week; observe precocious maturation of procambial strand (proc. s) of radicle and necrosed remnants of the root initials (ri). FIG. 12. Wheat, median face longitudinal section of differentiating embryo on liquid medium; hypertrophy of coleorhiza (colr), obliteration of the root meristem (rm) and root cap cells (rc) and disruption of organogenesis of the shoot (s). FIG. 13. Same as above, l.s. coleorhizal portion of embryo of near mature size on MH (0.5×10^{-3}M) for one week; degeneration of the root *in situ* is seen. FIG. 14. *Pennisetum*, l.s. young immature embryo on MH for one week, showing radial elongation of scutellar cells and root initials (ri). FIGS. 15, 16. Oat, l.s. immature embryos on MH, 0.5×10^{-3}M for two weeks; the root initials are transformed into permanent cells and the root cap (rc) and calyptrogen layer (caly) are degenerating. FIG. 17. *Pennisetum*, l.s. immature embryo on MH (10^{-3}M) + IAA (10^{-4}M); explanation in text. FIG. 18. Same as above, of young differentiating embryo on MH for one week. FIG. 19. Same as above, of a differentiating embryo; disruption of organogenesis following elongation of cells is marked. FIG. 20. Same as above, of young immature embryo showing radial elongation of scutellar cells and root cap cells (rc). FIG. 21. Same as above, of a differentiating embryo showing formation of a separation layer (sl) around the coleoptile (col) and failure of root formation within the coleorhiza (colr).

initials was marked in embryos that were differentiated but immature at the time of culture. Necrosis of the epidermal and one or two hypodermal layers of the scutellum was also observed (fig. 20).

Another striking effect although sporadic, was the severance of the shoot apex in immature embryos by the formation of a separation layer (sl) around the base of the coleoptile (col) at the point of insertion of the scutellum to the former (fig. 21). The row of cells immediately above this layer was in a state of collapse. The scutellar cells were radially elongated whereas those of the coleorhiza were considerably enlarged. A root was never formed.

The phenomenon of abscission of the shoot apex intact, in an embryo of near mature size is shown in figure 22. Necrosis of a few rows of cells below the coleoptile through the mesocotyl region was also observed as darkly stained streaks.

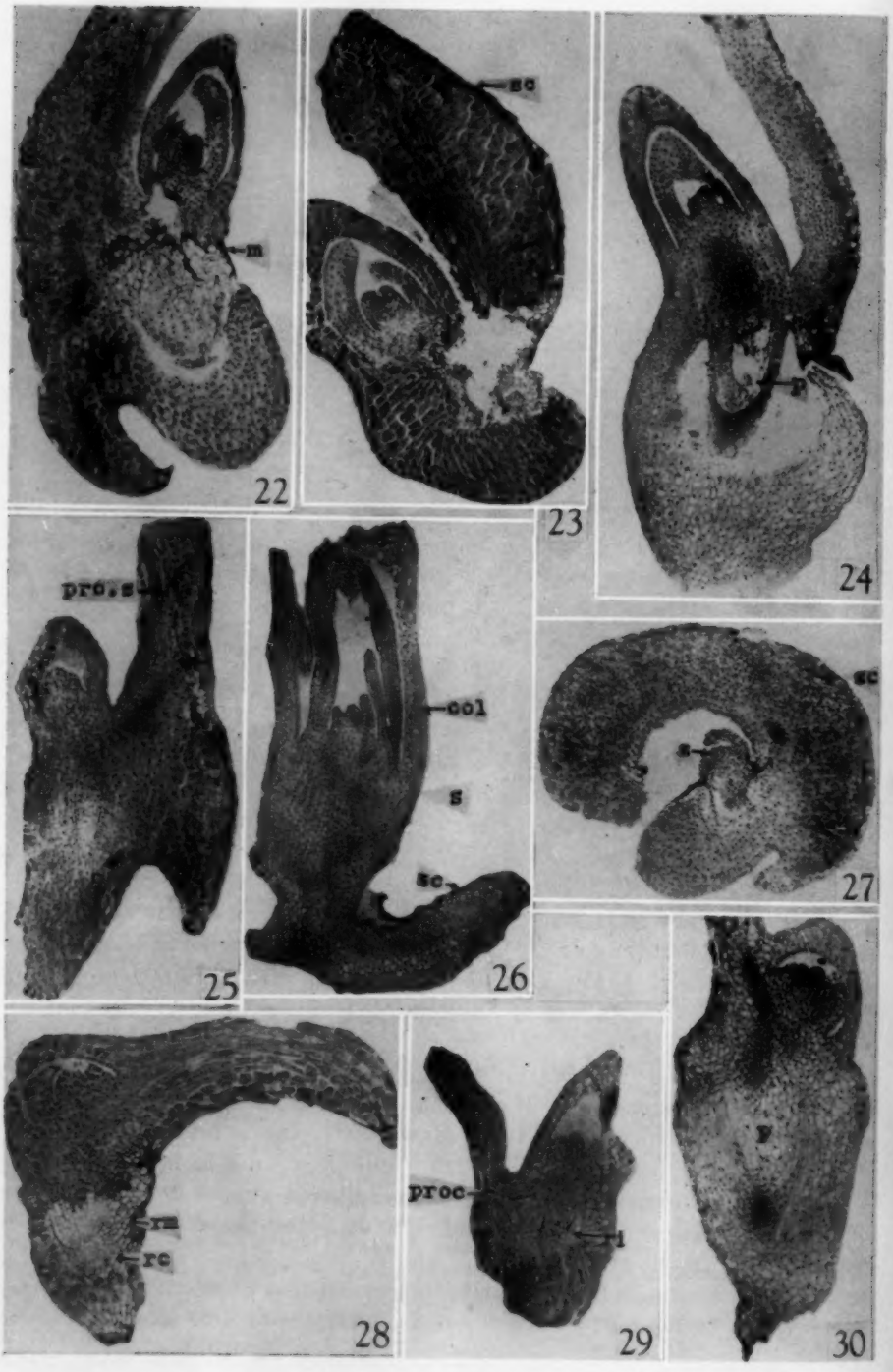
Figure 23 shows another instance where the scutellum is in the process of being abscissed as a result of obliteration of the cells of the mesocotyl and the primary root. Retention of the radicle within the swollen coleorhiza and inhibition of root growth following resorption of the plerome region (p) of the radicle in three-week old cultures of an embryo of near mature size is shown in figure 24. Those incubated for two weeks and transferred to fresh medium of the same concentration of the test chemical for a like period showed necrosis of the scutellar cells of the procambial strand (fig. 25 proc.s), the embryonal axis remaining undamaged.

Effect of MH, 1×10^{-5}M. Some stimulation to shoot growth followed by failure of root differentiation was observed in one-week old cultures of young *Pennisetum embryos* grown in this concentration (fig. 26) as compared to the control embryos (fig. 7). An instance of abscission of the shoot apex caused by necrosis of a cell layer below the level of attachment of the scutellum to the coleoptile was also observed (fig. 27).

Very immature embryos of wheat were equally sensitive to MH in regard to root meristems (fig. 28) as with *Pennisetum* embryos of the same age (fig. 29). With barley also, the cells of the radicle (r) were highly vacuolated indicating failure of differentiation of the three histogen layers (fig. 30).

Discussion. Maleic hydrazide as a general herbistat (Nickell 1955) appears to act selectively in checking growth and causing destruction of annual weeds in experimental plots. How exactly this is brought about and what tissues are primarily affected are questions on which investigators hold no single opinion. Several physio-morphological and anatomical evidences in regard to the influence of MH on plant tissues have been accumulated in recent years.

All experiments to date involving the use of this growth regulant have been carried out *in vivo* in the form of aqueous sprays or lanoline pastes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on the plant organ concerned and found effective at high concentrations. However, no record of growth effects of MH on embryos cultured *in vitro* is available. Although embryologic development in such experiments were not expected to show any marked departure from that *in vitro*, there is this difference that in artificial cultures, the naked embryo with its several organs is in direct contact with the test chemical whereas in field experiments the chemical has to penetrate several protective layers in order to be effective. The present objective was to consider not only induced growth responses but to observe any deleterious effects on embryo parts.

The investigations so far have shown that MH causes inhibition of growth even at high dilutions (Naylor & Davis 1950, Wittwer, Sharma, Weller and Sell 1950). Nickell's experiments (1952, 1953) on both normal and pathological tissues point to the same conclusion. MH significantly affected the growth of roots of *Avena* seedlings whether added to agar in which the roots were growing or applied to coleoptile stumps (Johnson & Greulach 1953). Growth stimulation at low cencentrations has been recorded by Ergle & McIlrath (1952) and Isenberg, Jensen & Odland (1954). The experiments *in vitro* under report while confirming its inhibitory role have, however, shown a stimulatory, effect on differentiated but immature barley and maize embryos at a concentration of MH, 1×10^{-5}M, causing growth in length of the coleoptile. This is probably attributable to its effect on cell elongation. Nevertheless the stimulation was only a temporary phase and further growth was arrested in cultures kept over a week. Of particular interest is the effect of MH in stimulating cell division at high dilutions, of bean segments in sterile cultures (Muzik & Cruzado 1957). Root inhibition following application of MH has been reported in oats (Johnson & Greulach 1953), wild onion and garlic (Moore 1950, Harris *et al.* 1954, Quoted by Zukel, 1952-55. An explanation of the mechanism by which this is brought about is sought in the present investigation based on anatomical studies of MH-influenced embryos *in vitro*.

All concentrations of MH proved fatal to root meristems in treated embryos of all ages and of several differentiating phases. Sectioned materials revealed that the group of apical initials with their immediate

FIGS. 22–25. Effect of MH (10^{-4}M) and FIGS. 26–30, of MH (10^{-5}M) on embryos. FIG. 22. *Pennisetum*, l.s. immature embryo on MH for 4 weeks. Note the necrosed cell layers across the mesocotyl (m) and loss of meristematic potentiality of the root. FIG. 23. Same as above; severance of the scutellum (sc) from shoot axis is seen. FIG. 24. Same as above; obliteration of plerome (p) of radicle is seen. FIG. 25. Same as above; note necrosed cells of procambial strand (pro. s) as dark streaks. FIG. 26. Same as above, on MH (10^{-5}M) for one week; stimulation of shoot (s) growth and failure of root formation is seen. FIG. 27. Same as above, of young differentiating embryo; abscission of shoot has commenced. FIG. 28. Wheat, l.s. embryo showing injury to root meristem (rm). FIG. 29. Same as above, of *Pennisetum;* necrosis of procambiam (proc) and adverse effect on root initials (ri) are seen. FIG. 30. Same as above, of barley; plerome (p) of root shows loss of differentiation of the histogen layers.

derivatives in the plerome region was necrosed. The calyptrogen layer had collapsed and was flattened out, and the root cap cells underwent vertical elongation followed by vacuolation before their final resorption. The cells of the periblem failed to differentiate into their constituent elements (Greulach & Haesloop 1954) but were hypertrophied. In *immature* embryos of barley a precocious maturation of the vascular elements into scalariform tracheids accompanied by necrosis of the root initials was noticed. Neither a primary root nor any adventitious roots were ever formed in cultures of embryos undergoing organ differentiation at the time of inoculation.

Wheat embryos showed the apical meristems of both the shoot and the root to have been depleted of their cell contents presenting a bleached appearance. In oats and barley degeneration of the root cap cells occurred *in situ* within the coleorhiza which had considerably swollen up; and the root initials were transformed into permanent cells having lost their nuclei and acquired thick walls. In general, MH was most injurious primarily to the young root tip meristem than to the shoot meristem, inhibiting its differentiation into the various histogen layers. Irregularities attributed to this substance as an antimitotic agent were never observed in embryos grown under any concentration of MH. In fact none of the embryos ever showed any mitosis.

Anatomy of MH-treated embryos of *Pennisetum* indicated that the cells of a young differentiating embryo became elongated accompanied by loss of meristematic potentialities. Further evidence of this was secured from a study of differentiated but immature embryos in which the scutellum had swollen up largely due to radial elongation of the cells indicating hormone-like action of MH. This phenomenon has also been reported in leaves of barley (Gifford 1956) although according to Leopold & Klein (1951, 1952) MH inhibits cell elongation and functions as an antiauxin under certain conditions. Accumulation of deep staining materials in intercellular regions resulting in part from necrosed cells was frequently observed in scutellar tissue of embryos subjected to high concentrations of MH to prolonged periods. The substance apparently caused no deleterious effect on the coleoptile and the first few leaves of the shoot. Collapse of the sieve elements of the procambial strand was, however, evident.

Another significant feature was the formation of an abscission layer in the region below the coleoptilar node cutting off the shoot apex from the root of treated embryos in all concentrations of MH. This phenomenon has been reported in cotton which showed increased defoliation when treated with the test chemical (Hall *et al.* 1953, quoted by Zukel, 1952–55).

That the adverse effect of MH on embryos could be overcome by external supply of IAA was evident from sectioned materials of treated embryos in which the root tip remained intact showing no injurious effect

on meristems although proliferation of the coleorhizal cells and copious formation of root hairs were marked.

To sum up, the consensus of evidence indicates that (1) MH is a growth suppressant, (2) the stimulation to growth of coleoptile and the scutellum observed in treatments with low concentrations of MH is entirely due to cell elongation suggestive of hormone-like action of the chemical, (3) inhibition of growth by cessation of activity of the shoot meristem is brought about by the destruction of the root initials and their immediate derivatives or by the accelerated maturation of the three histogens and collapse of the calyptrogen layer of the root, (4) MH in combination with higher doses of IAA may act antagonistically (Gautheret 1952), (5) MH primarily affects the root meristem than the shoot meristem (Harris *et al.* 1954), and (6) differences in growth response are dependent on the degree of maturity of the embryo at culture than on the concentration of the chemical.

I wish to record my deep sense of gratitude to Professor P. Maheshwari for encouragement and facilities. Thanks are also due to Mr. N. S. Ranga Swamy, M.Sc., for assistance and to the authorities of the National Institute of Sciences of India for the award of a Senior Research Fellowship to the author during the tenure of which this work was carried out.

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Literature Cited

Ergle, D. R. & McIlrath, W. J. 1952. Response of the cotton plant to late and localised applications of maleic hydrazide. Bot. Gaz. **114**: 114–122.

Gautheret, R. J. 1952. Recherches sur l'action combineé de l'hydrazide maléique et de l'acide indole-acétique sur les cultures des tissus de Topinambour. Compt. Rend. **234**: 2218–2221.

Gifford, E. M. Jr. 1956. Some anatomical and cytological responses of barley to maleic hydrazide. Am. Jour. Bot. **43**: 72–80.

Greulach, V. A. & Haesloop, J. B. 1954. Some effects of maleic hydrazide on internode elongation, cell enlargement and stem anatomy. Am. Jour. Bot. **41**: 44–50.

Hoagland, E. R., Elliot, F. C. & Rasmussen, L. W. 1953. Some histological and morphological effects on a spring wheat. Agron. Jour. **45**: 468–472.

Isenberg, F. M. R., Jensen, C. O. & Odland, M. L. 1954. Effect of maleic hydrazide on respiration of mature onion bulbs. Science **120**: 464–468.

Johnson, S. P. & Greulach, V. A. 1953. Some effects of maleic hydrazide on respiration of mature onion bulbs. Elisha Mitchell Scientific Soc. **69**: 177–181.

Leopold, A. C. & Klein, W. H. 1951. Maleic hydrazide as an anti-auxin in plants. Science **114**: 9–10.

———. 1952. Maleic hydrazide as an anti-auxin. Physiol. Plantar. **5**: 91–99.

Mericle, L. W., Eunus, A. M. & Mericle, R. P. 1955. Effect of maleic hydrazide on embryologic development. I. *Avena sativa*. Bot. Gaz. **117**: 142–147.

Moore, R. H. 1950. Several effects of maleic hydrazide on plants. Science **112**: 597–598.

Muzik, T. J. & Cruzado, H. J. 1957. Differentiation of bean segments in sterile culture with added IAA, 2,4-D and MH. Plant Physiol. Suppl. **32.**

Narayanaswami, S. 1959. Experimental studies on growth of excised grass embryos *in vitro*. I. Overgrowth of scutellum of *Pennisetum* embryos. (in press.)

Naylor, A. W. & Davis, E. A. 1950. Maleihydrazide as a plant growth inhibitor. Bot. Gaz. **112**: 112–126.

Nickell, L. G. 1952. The control of plant growth by the use of special chemicals with special emphasis on plant hormones. Survey biol. Progr. **2**: 141-195.

————. 1953. Effect of maleic hydrazide on normal and atypical growth of *Rumex acetosa*. Am. Jour. Bot. **40**: 1–3.

————. 1955. Effects of antigrowth substances in normal and atypical plant growth. Antimetabolites and Cancer. AAAS. 129–151.

Schoene, D. L. & Hoffmann, O. L. 1949. Maleic hydrazide, a unique growth regulant. Science **109**: 588–590.

Struckermeyer, B. E. 1953. Effect of maleic hydrazide on the anatomical structure of Croft Easter lilies. Am. Jour. Bot. **40**: 25–29.

Wittwer, S. H., Sharma, R. C., Weller, L. E. & Sell, H. M. 1950. The effect of preharvest foliar sprays of certain growth regulators on sprout inhibition and storage quality of carrots and onions. Plant Physiol. **25**: 539–549.

Zukel, J. W. 1952–55. Literature summary on maleic hydrazide. U. S. Rubber Co. Publications. Naugatuck, Conn.

BULLETIN OF THE TORREY BOTANICAL CLUB

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THE CYTOKINETIC ORIGIN OF THE MONOLETE SPORES OF POLYPODIUM VIRGINIANUM

NORMAN P. MARENGO

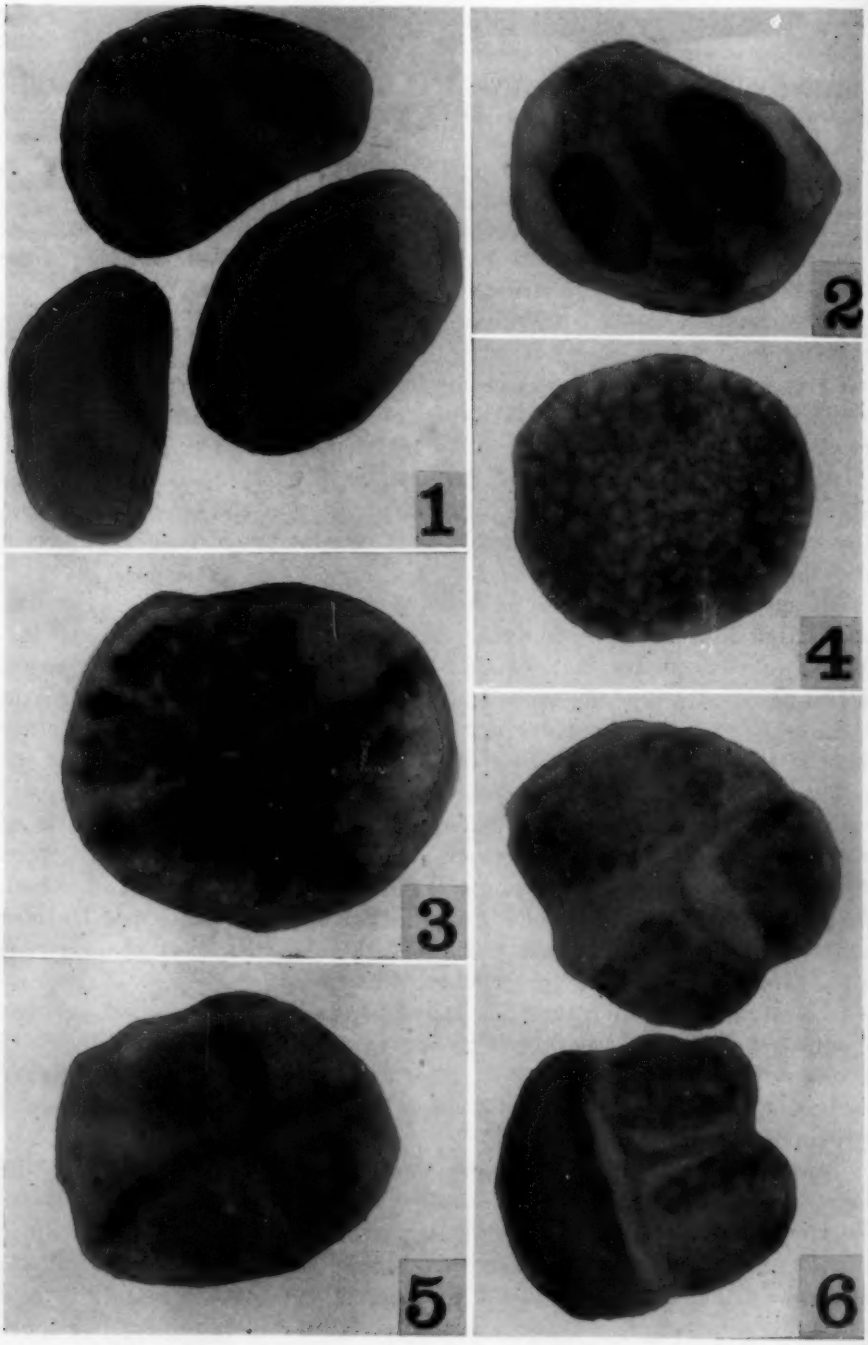
In ferns, the arrangement of spores in the quartet which originates from a single spore mother cell may be of two types (Bower 1923). If the newly formed spores are arranged in a tetrahedrally symmetrical fashion, the mature spore bears a tri-radiate scar on its surface This scar is the physical remnant of the spore's initial shape as one of four triangular spherical pyramids with apices at the center of the spore mother cell from which they arose. Spores of this type are designated as trilete. The cytokinetic basis of this type of spore has been described in *Osmunda regalis,* in which species the behavior and distribution of cytoplasmic inclusions of the spore mother cell during meiosis suggest that the tendency to form a spore quartet of the tetrahedral type is present prior to the completion of cytokinesis (Marengo 1954).

In species having the second type of spore quartet arrangement, the maturation divisions result in the formation of four spores which are wedge-shaped quarter spheres of the spore mother cell. These spores are arranged in two pairs, with the long axes of one pair at right angles to the long axes of the other pair. The line marking the junction of each spore with the other three of the quartet remains as a single straight scar on the surface of the mature spore. Spores of this type are referred to as monolete.

Sporogenesis studies of polypodiaceous ferns have indicated that in at least two species the pattern of cytokinesis in this process is directed toward the formation of a quartet of monolete spores from each spore mother cell. These studies include *Nephrodium molle* (Senjaninova 1927) and *Onoclea sensibilis* (Marengo 1949). In neither of these studies were the external surface features of the mature spores defined.

A search of the literature has failed to disclose a cytological account of sporogenesis in *Polypodium virginianum,* and the definition of its spore as monolete or trilete has not been recorded. It is the object of this paper to classify the spore type of *Polypodium virginianum* and to describe the cytokinetic basis for its origin.

Materials and methods. Young sori with sporangia containing the desired stages in sporogenesis were excised from fresh fronds of *Polypodium virginianum* growing on limestone outcrops in Ulster County, N. Y. Since previous accounts of sporogenesis in *Onoclea, Nephrodium* and *Osmunda* have shown that differences in the behavior of cytoplasmic inclusions preserved by mitochondrial fixatives were clearly related to the type of spore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quartet produced, the sori were fixed for mitochondrial preservation according to the method of Lewitsky (1925). Material was embedded in 56–58° paraffin, sectioned at 3 micra and stained in iron hematoxylin.

Mature spores were fixed in F.A.A., dehydrated in ethyl alcohol, cleared in xylene and mounted in gum damar.

Observations were made using a Bausch and Lomb Dynoptic laboratory microscope with a 97X achromatic oil immersion objective. Photomicrographs were taken with a Brinkmann Model "U" photomicrographic camera using 4″ × 5″ Kodak Panatomic-X cut film.

Observations. The spores of *Polypodium virginianum* were found to be unmistakably of the monolete type. The scar characteristic of this type of spore appears as a straight line centrally located on the flat side of the spore, and in direction is parallel to its long diameter (fig. 1).

At the termination of the first meiotic division of the spore mother cell, the cytoplasmic inclusions preserved by mitochondrial fixation are arranged, as in *Onoclea* and *Osmunda*, in a compact disc interposed between the two nuclei (figs. 2, 4). No evidence of a cell plate is discernible at this time. As the second division proceeds, this disc of granules retains its shape and identity.

At the metaphase of the second division the difference in the orientation of the spindles with respect to each other is clearly evident. Favorable sections showing the lateral view of the metaphase of one of the division figures will include a polar view of the chromosomal plate of the other (fig. 3).

The disc-shaped mitochondrial localization remains clearly defined at this time, and a surface view of this structure (fig. 4) indicates some vesicular organization of the granules within the disc. The significance of this is not clear at present.

At the termination of the telophase of the second division, although the disc of inclusions is still sharply defined, it clearly displays a two-layered organization (fig. 5). This suggests that cytokinesis has now occurred, with one cell plate having been formed within this mitochondrial disc. The two additional cell plates formed at this time appear to originate independent of the disc of inclusions, and are laid down between the telo-

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FIGS. 1–6. FIG. 1. Photomicrograph of mature spores of *Polypodium virginianum*. Fixed in F.A.A. Unstained. Magnification × 730. FIGS. 2–6. Photomicrographs of sections of stages in the division of spore mother cells of *Polypodium virginianum*. Lewitsky fixation. Iron hematoxylin stain. Thickness 3 micra. Magnification: Figs. 2, 4–6 × 1150; Fig. 3. × 1524. FIG. 2. Interphase following first division. Mitichondrial disc between nuclei shown in cross-section. FIG. 3. Metaphase II showing spindle orientation, metaphase plates in cross-section and polar view and mitochondrial disc. FIG. 4. Section parallel to and including mitochondrial disc of fiig. 3. FIG. 5. Telophase II showing persistence of mitochondrial disc and its separation into two layers. FIG. 6. Interphase II. Cytokinesis complete. Each group shows cross-section of two spores and a long section through one spore.

phase nuclei in each half of the spore mother cell (fig. 5). Since the spindle axes of this division are at right angles to each other, the cell plates between the telophase nuclei will also be at right angles to each other and also perpendicular to the cell wall which will have formed within the mitochondrial disc.

As the newly-formed spore nuclei reach interphase, the cell walls separating them become clearly evident, and the mitochondrial localization characteristic of earlier stages is lost (fig. 6). A section through the spore quartet, if favorably taken, will include the long diameter of one of the spores and sections across the short diameters of the others (fig. 6). When the mature spores finally separate from each other, the lines of junction in the young spore quartet remain as the typical monolete scars of spores of this type (fig. 1).

Discussion. At the end of the first meiotic division in *Polypodium virginianum* the cytoplasmic inclusions preserved by Lewitsky's fixation are arranged essentially as they have been described in *Onoclea, Nephrodium* and *Osmunda*. At this time a sharply defined disc of granules is interposed between the nuclei resulting from the first division. As the second division proceeds, the orientation of the spindles and the persistence and subsequent division of the mitochondrial plate are similar to comparable stages in *Onoclea* and *Nephrodium*. In *Polypodium virginianum*, the mitochondrial plate, although apparently separated into two layers by the developing cell walls, keeps its sharply defined shape and position until cytokinesis is complete. This behavior is in marked contrast to that observed in *Osmunda*, in which this disc of granules is transformed, prior to cytokinesis, into a six-partite figure, dividing the spore mother cell into four tetrahedrally arranged (trilete) spores.

The marked difference between the results of cytokinesis in the polypodiaceous ferns considered (*Onoclea, Nephrodium, Polypodium*) and equivalent stages in *Osmunda* might lead to a suggestion that this difference may have some taxonomic significance. Erdtman (1957), however, lists and illustrates spores of 28 polypodiaceous ferns which have trilete spores. If researches into the cytokinetic origin of the trilete spores of these species reveal a pattern essentially like *Osmunda*, it is scarcely valid that the tendency to produce monolete or trilete spores is of any taxonomic importance.

Of the 28 trilete polypodiaceous genera listed by Erdtman (1957), five are included in Gray's Manual of Botany (Fernald 1950). These are *Adiantum, Cryptogamma, Pteridium, Dennstaedtia* and *Pellaea*. Although these five genera seem scarcely more related to each other than to other members of the Polypodiaceae, they appear to have one distinctive morphological feature in common. In all of these five genera producing trilete spores, the indusium is formed entirely or in part by the revolute margin

of the frond or its segments (Fernald 1950). This feature is found in no other polypodiaceous genera listed in Gray's Manual. If a survey of the other trilete polypodiaceous genera listed by Erdtman (1957) reveals a similar common morphological distinction, the trilete or monolete nature of the fern spore and its origin may acquire additional taxonomic signficance.

SUMMARY

1. Young sori of *Polypodium virginianum* containing meiotic stages in sporogenesis were excised from fresh fronds, fixed for mitochondrial preservation by Lewitsky's method, sectioned at 3 micra and stained with iron hematoxylin. Mature spores were fixed in F.A.A. and mounted unstained.

2. Examination of mature spore preparations indicated that the spores of *Polypodium virginianum* are monolete.

3. Study of stained sections indicated that the pattern of nuclear division and cytokinesis in *Polypodium virginianum* is essentially similar to *Nephrodium* and *Onoclea* and reflects the monolete nature of the mature spore.

4. The trilete polypodiaceous ferns listed in Gray's Manual are discussed and the possibility is considered that their relationship may be reflected in the type of spore they produce as well as in the position of their sporangia under the revolute margin of the frond.

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Literature Cited

Bower, F. O. 1923. The ferns. Cambridge.

Erdtman, G. 1957. Pollen and spore morphology/plant taxonomy. An introduction to palynology. II. New York.

Fernald, M. 1950. Gray's manual of botany. New York.

Lewitzsky, M. 1925. Die Chondriosomen in der Gonogenese bei *Equisetum palustre* L. Arch. Wiss. Bot. **I**: 301–317.

Marengo, N. P. 1949. A study of the cytoplasmic inclusions during sporogenesis in *Onoclea sensibilis*. Amer. Jour. Bot. **36**: 603–613.

———. 1954. The relation of the cytoplasmic inclusions to the establishment of tetrahedral symmetry in the spore quartet of *Osmunda regalis*. Bull. Torrey Club **81**: 501–508.

Senjaninova, M. 1927. Chondriokinese bei *Nephrodium molle* Desv. Zeitschr. Zellf. Mikr. Anat. **6**: 493–508.

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TORREYA

ASPEN INVASION OF PRAIRIE

MURRAY F. BUELL AND HELEN F. BUELL

The village of Waubun in Mahnomen County, Minnesota lies 30 miles west of Itasca Park. It is within the area mapped in 1884 by Upham as prairie but near its eastern edge (Upham 1884). There are still a few good relicts of prairie left in this vicinity which have escaped the plow. Just to the west of Waubun much of the low, rolling prairie has been too poorly drained to be cultivated. Increasing improvement of drainage there, resulting from extensive ditching along the main highways, has finally made cultivation of the low prairie areas feasible in recent years. Where cultivation has not been possible the harvesting of wild hay has been and still is, practiced.

Thickets, predominantly of *Populus tremuloides*, occur here and there in this undulating low prairie. They commonly are centered about depressions. A group of such aspen thickets occur scattered in a relict prairie area on the north side of section 21, T.143 N. R. 42 W., adjacent to an unimproved dirt road along the section line. Annual mowing of the prairie between the aspen thickets has been the practice.

Scattered among the prairie grasses in the vicinity of the aspen thickets are many small shoots of aspen about the average height of the grasses. Obviously these small aspens have been subject to annual mowing along with the harvest of the prairie hay.

Being curious as to what sort of a root system these small aspens might have, we started carefully excavating one of them that was located 20 meters from the edge of the nearest aspen thicket. This turned out to be a more ambitious project than we had anticipated, since it was attached to a sparsely branched root of remarkably uniform diameter extending a total length of 31.7 meters. We kept a record of the features of this root as it was excavated.

At the small plant where the excavation started the root was 2 cm. deep in the ground. It extended 2½ meters farther into the prairie at depths of 5–15 cm. with no branches. The last 6 dm. were dead.

Tracing the root in the other direction, toward the aspen thicket, we found that it continued at depths varying from 3 to 15 cm. for 10 meters. Two small horizontal branch roots, a cluster of small "feeding" roots, and a leafy, upright stem were encountered at different points. The maximum diameter attained by the root over this distance was one centimeter.

Continuing to trace the root beyond these 10 meters back toward the thicket, we found it descending rapidly soon reaching a depth of 90 cm. Here it was no longer in the black A horizon of the prairie soil but in the whitish B horizon. It stayed at this depth only a short distance. Within 2¾ meters from the point it started to descend it was back again to only 3 cm. below the surface and for the rest of the distance it continued in the black A horizon mostly within 10 cm. of the surface and nowhere going deeper than 30 cm. There were four more branch roots and no green leafy shoots the rest of the distance. There was a cluster of buds and a few short, young white shoots below the soil surface at one point and another cluster of short white shoots at another point. At the margin of the thicket it bore many small descending roots with numerous branches and mycorrhizal rootlets. The root appeared to come from the nearest aspen tree but turned out to simply pass directly under this as well as the next adjacent tree, both of which were 5–6 inches in diameter and about 20 years old. It had its source just below the ground level as a branch of a 4-inch root of a 5-inch, aspen tree located 9 meters from the margin of the thicket. It branched off the larger root about 8 cm. from the base of the tree. The tree from which the root came appeared itself to have originated as a root sprout about 20 years previous. Even at its source, this 31.7 meter long cord-like root was only 5 cm.

in diameter and for most of its length was 1 cm. or less in diameter. Further digging in other similar prairie areas indicates such spread of aspen by roots extending into the prairie sod to be a common phenomenon in this region.

Two other roots were excavated and when cross sections of all three roots were examined for growth rings it turned out that the rings were not everywhere equally distinct. At and near places where shoots had developed the root was thicker than long stretches between shoots. At these thicker places rings were fairly distinct. Where the root was thinnest between shoots no rings could be made out. The cross sections of the stele at such places sometimes only 1½ to 2 mm. in diameter, apparently consisting only of the first year's growth. Each of the three roots studied descended to the white soil beneath the black A horizon of the prairie soil for a distance and in none of them was more than 1 growth ring evident while they were at the depth. To get some idea when the roots were growing at this depth we counted growth rings at the point nearest to this where they were distinct enough to count and found that it was from 4 to 6 years before they were excavated or between 1951 and 1953. The age of the longest root excavated as indicated by growth rings nine cm. from its source where most of the rings were distinct was 23 years. This would mean that the root grew at an average rate of nearly a meter and a half a year. A second root that was traced to its source grew from a 24 year old tree at only a slightly slower rate.

In the region of low, rolling prairie of southern Mahnomen County and adjacent areas the pressure of the spread of aspen from scattered thickets is so great that some frequently recurring restricting factor must have been continuously acting to maintain the prairie. Without such a factor this low-land would rapidly become aspen forest. By virtue of a chance recent burning of one of the nearby aspen thickets we were able to observe the effects of fire. The fire killed both the aspen trees and the sprouts. In Indian days fires were known to sweep through this area regularly. Although the aspen and other species associated with it in these groves can regenerate readily after fire as Ewing (1924) has pointed out, the aspen groves must have been kept quite reduced and the trees small and weakened as a result of the frequent fires. Thus the pressure on the prairie from such groves would not have been great. Following settlement, the initiation of the practice of harvesting wild prairie hay between the groves has served to protect the groves. Fires no longer swept through the area. This has resulted in vigorous growth of the aspen and healthy support for their long cord-like propagating roots that grow out into the prairie sod. Wherever mowing stops for a period of years the aspen shoots grow up rapidly into thickets. Such new thickets are readily found.

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Literature Cited

Ewing, J. 1924. Plant successions of the brush prairie in Northwestern Minnesota. Jour. Ecol. **12**: 238–266.

Upham, W. 1884. Catalogue of the flora of Minnesota. Minn. Geol. and Nat. Hist. Survey, Ann. Rept. **12**: 5–193.

BOOK REVIEWS

Soil Fertility and Animal Health. By Wm. A. Albrecht. Fred Hahne Printing Company, Webster City, Iowa. 1958. $3.98.

To most of us any mention of "soils" brings to mind the fertilizers and manures that we apply to them, the tools with which we cultivate them, the color and texture we observe, and the amount of plants we achieve. To the professional pedologist "soils" means ion exchange, the energies of colloidal surfaces, and the differential equations in which events there must be described. Soil, however, is the concern not only of the gardener, the farmer, and the scientist, but—since we all must eat—of all of us. This little volume emphasizes the real importance of soil as the substratum of all our living.

It brings scientific research into focus upon the problems of the farmer and points out the relations between his product and the health and nutrition of the rest of us.

Perhaps the central theme of the book is the pattern of soil in the United States and its development under the progressively higher rainfall as we go from west to east. Albrecht shows how in the more highly developed soils leaching has removed more of the calcium, magnesium, and other nutrients, so that "in such climatic areas and on soils so highly developed, the protein-rich vegetation, like the grasses, does not result. . . . Instead, the forests making mainly carbohydrate, like cellulose, prevail there." It is a contrast between quality and quantity. Agriculture *as an industry* flourishes through the raising of *bulk*, whether in its plants or its animals. But the contention of this book is that this sort of growth is not conducive to health, that plants, animals, and ourselves all suffer from a lack of nutritive balance. Similar effects are seen also with increase of temperature (and here, I suppose, the author has in mind "mean temperatures," though he is not plain on this point; the Dakotas experience higher temperatures than the "deep South"). The familiar theme is developed that by removing crops man denudes his soil of organic as well as inorganic nutrients. Even crop rotation is shown to be injurious. It is shown, moreover, that mere addition of nitrogen is not enough to ensure proper synthesis of proteins by animals: it must be nitrogen as amino acids, in proper proportions. In short, our economies have distorted our agriculture to the point where we may be defeating our own ends.

One of the most entertaining and instructive features of the book is the frequent reference to "cows as chemists." The roaming herds of bison are called as witnesses to the proper way of life. (One wonders a little if an agriculture built solidly on these principles could support the vast human populations of today—and tomorrow; here again quality may be in conflict with quantity!) Certainly the evidence is convincing of the effects of soil deficiencies on the health of grazing animals, and through them on ourselves. But Albrecht goes too far in implying that proper nutritive balance will dispose of all the problems of plant pathology, and in stating that the breeding of resistant races of plants is without point. Of course the very vastness of the subject, which embraces practically all phases of nutrition and health, makes some erroneous judgments inevitable.

There is much more of interest in this book, which the reader must discover for himself. In spite of being directed at the layman, however, it is not easy reading. At least one reader admits to having been confused by what seems to be the conversion, on p. 183, of indole directly into indole acetic acid and thence into tryptophan. It is, of course, well established that in plants indole acetic acid is derived from tryptophan.

The book, which was assembled from a series of separately published articles, is marred by a number of unfortunate misprints, and its design reflects the inexperience of a "small-town" printer. However, the theme is of such importance and has been so curiously neglected that minor faults are to be overlooked. We may hope that this work will find many readers and lead to further exposition of the subject.—H. W. RICKETT.

Drawings of British Plants. Part XII. Umbelliferae (1). By Stella Ross-Craig. G. Bell and Sons Ltd., London. 1958. 9/6 [$1.33].

This part includes drawings of 36 species in 27 genera of Umbelliferae. Of these no less than 17 species have been reported as adventive in North America, and some have become common. In this family especially the beautiful drawings of the small flowers and fruit will certainly be helpful in identifying genera and species. Flowers are shown in longitudinal section, fruit in cross section, besides perspective views of each, highly magnified. The habit of each species is also well illustrated, mostly with the underground parts displayed.—H. W. RICKETT.

A Field Guide to Trees and Shrubs. By George A. Petrides, xxxii + 431 pp. Houghton Mifflin Co., Boston. 1958. $3.95.

Dr. Petrides has written what will be a welcome reference for the non-botanist, and a useful book for the professional botanist in the identification of woody plants.

For many years the non-botanist had to visualize the appearance of shrubs from lengthy descriptions, utilizing latinized terminology. If pictures were available, they might emphasize a characteristic of the plant, such as size, color or other micro-climatic variations not useful in identification. What has been needed is a field book with illustrations of all plants, and with illustrations in which the field marks are presented, and confusing detail eliminated.

A procedure like this had been developed by R. T. Peterson for bird identification. The publication of the field guides to birds resulted in an increase in bird watching and certainly contributed to the professional growth of ornithology. Now Dr. Petrides, using the Peterson system, and with Dr. Peterson as editor and contributor, illustrates most of the woody plants of the north-eastern United States. The illustrations are diagrammatic, details are sacrificed for clearity of field mark presentations, and diagnostic features of leaves, buds and flowers are indicated. One feature of the book is the grouping of those plants with similar leaf growth. Though this, in several cases, puts plants of different families together in the illustrations and in the text, no one should object. This is, after all, a *field* guide, not a volume on plant taxonomy. The text is concise, and descriptions are concerned largely with identification features. Terminology is non-technical, and loses nothing by being so. "Heartshaped" and "overlapping" serves well for "cordate" and "imbricated." Similar species are compared so that one may have some idea of plants that might be confused with the one being identified. Wildlife uses of some species of trees and shrubs are also listed. As a practical aid to identification of woody plants this book is unsurpassed. Both text and illustrations are well arranged and easily understood. Some of the bud drawings are small, but a hand lens will make details clear.

Anyone using *A Field Guide to Woody Plants* will be able to identify common trees and shrubs within a short time. For the more advanced, this book will aid in identification of rarer species. All in all, this field guide may do for interest in botany what Peterson's bird guides have done for interest in ornithology.—JEFF SWINEBROAD, Douglass College, Rutgers—The State University of New Jersey.

Woody Plants in Winter. By Earl L. Core and Nelle P. Ammons. viii + 218 pages, figs. 313. The Boxwood Press. Pittsburgh. 1958. Paper $2.75; Cloth $4.00.

The area covered by this book is roughly coincident with that of Gray's Manual, 8th Edition, which is the authority generally followed in nomenclature. A 15 page section, the book is not formalized by numbered chapters, over 50% illustrations, introduces the terms most used in identifying woody plants while dormant. There is also a glossary of something over 7 pages preceding the index.

The key to genera also takes 15 pages. 166 pages are required for the "Descriptions of genera and species of woody plants." There is a brief but adequate bibliography, mostly the standard works and manuals.

I have made no effort to proof the book on typographical errors, though none were found in the reviewing. Neither have I checked the range of measurements nor the fidelity of drawings for accuracy. Defections could probably be found but the repeated use of this material in student manual form has, I assume, brought out the most useful range and the most reliable representation of form. The copious pen and ink sketches certainly prove useful in species determination.

The keys (dichotomous) were tried with several species. No tricks were discovered. Silver maple and sassafras went through readily the first try. Cherry has bothered me in other keys too. This time the large central bundle scar made me careless and I ran it as bundle-trace one, which did not work. In rechecking, it was not difficult to locate the careless error and the genus was quickly located. The species key worked nicely. One may wonder why the aromatic bark character is not given a more major position as Graves has done.

The gymnosperms came through easily. Ginkgo is omitted (though lilac and forsythia are included among angiosperms). Gymnosperms are not kept together in the

genus key. The first choice is evergreen or deciduous and this of course results in systematically strange bedfellows. *Taxodium* comes up in the first choice of the deciduous key (cumulative No. 31) while *Larix* is not reached until No. 203. The descriptive section is systematically arranged however. The authors have included only the more easily determined species and the species groups of *Crataegus* and *Rubus*. They have disagreed with Fernald in keeping the genus *Aronia* distinct from *Pyrus*. There also appears to be some difference of opinion about the species of *Amelanchier*. I made no systematic search for exclusions or omissions. Some are to be expected in a book of this size. *Hudsonia tomentosa* is present; *H. ericoides* is not. I did not find *Corema*, *Empetrum*, or *Leiophyllum*. *Rhus radicans* is made inclusive and *R. toxicodendron* is a synonym in part. Poison oak is not to be found. The Compositae family is represented by *Baccharis* but not by *Iva*, which was perhaps considered insufficiently shrubby.—J.A.S.

The Tree Identification Book. By George W. D. Symonds, with 1,539 photographs by Stephen V. Chelminski. 272 pages, each $8\frac{1}{2} \times 11$ inches. M. Barrows & Co., New York, 1959. $10.00.

The sub-title, "A New Method for the Practical Identification and Recognition of Trees," should not be omitted because the author makes some effort at the outset to assure the viewer of this book that recognition is what he intends to stimulate. With a key, even a pictorial key such as Jacques (How to Know the Trees—Wm. C. Brown Co.) one has to identify an unknown tree by reading and making choices that jump from leaves to flowers, pith, and sundry other parts. In this book, one merely looks at pictures and recognizes his tree upon sight. Just turn past the 17 pages of opening amenities to where the pictures start, many are actual size and anyway the scale is always indicated.

We had a silver maple and the first 4 pages of pictures show leafy twigs of those genera where the leaves are oppositely arranged. It was not difficult to see that ours was a maple, though the twig photographed was sugar maple, none of the other simple leaves with opposite arrangement were lobed. The next two pages repeat these genera with photographs of the twigs in winter. Doing it in March we had no difficulty selecting the maple as the twig most closely resembling ours. A red maple with flower buds and a sugar maple were photographed actual size. In each case the maple was accompanied by 96, a number referring to master pages, see below.

The next page displayed photographs, again natural size, of the four tree genera that may be recognized by their thorns. Now admittedly recognizing a hawthorn is a long way from specific identification and Symonds avoids the matter by stating, "800–1000 species in North America alone." Do you care which hawthorn? If so, you need a more profound treatise and if you succeed you are out of the non-professional class.

There are 24 pages of leaf photographs. Our silver maple was easily found. In the 24 pages of tree flowers the silver maple and red maple, both flowering before leafing, were easily separated. We found 18 pages of fruits, all actual size and including the 4 arboresent species of Rhus. The whole gamut of twigs and buds are brought together on 12 pages and bark photographs occupy 18 pages. The latter are particularly effective. Each has a view at perhaps 8 feet and a close-up. They are all at the same relative scale and some are repeated several times to show the range of variation. Another useful innovation is to group the species with similar features together so one may easily contrast them. We found our silver maple beside a horsechestnut and above a red maple. Had you noticed that tips of the bark flakes of silver maple tend to curl up more than those of other trees with similarly flaky bark? Back at the tree we verified this. A red maple is shown beside a white oak. The red maple is variable and we found it in two other places. The tupelo appears at least 5 times.

Four pages are used for the needle-leaved trees (Conifers). Here as in some other places the photos are accompanied by helpful annotations, e.g.; spruce has four-sided needles, other needles growing singly are flat; cone differences in the cedars.

By this time one should have determined the genus and its number with certainty. Turn to Part II which consists of 127 master pages, at least one to each genus (Hack-

berry) and encompassing over 130 trees in all. Here one finds the whole tree and all of the preceding features brought together. All species that are handled for each genus are together here, not always so previously. Here also are annotations, scientific name, and range. The genus Acer has 10 pages. We might not have selected silver maple from the photographs of whole trees and we might have still confused the bark with red maple in large trees, but the leaves, twigs (buds), flowers, and fruit were easily selected and at least one of these features would always be in evidence.

The Table of Contents includes a shaded, finger index to the sections of Part I and to the Master pages, Part II. Following the Master pages there is a short bibliography—mostly the manuals, a glossary, and an index—to master pages only.

The Frontispiece—a full page showing perhaps one-third of a field grown (stone wall) white oak overtopping a young copice of the old field succession—is beautiful as are all of the photographs which Chelminsky released. If you wish to recognize trees or to have a new and attractive number on your living room coffee table, you may well exchange an engraving of Hamilton for this collection of half tones. Keep the dust cover on, though, the board covers are less attractive.—JOHN A. SMALL, Douglass College, Rutgers—State University of New Jersey.

BULLETIN OF THE TORREY BOTANICAL CLUB

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INDEX TO AMERICAN BOTANICAL LITERATURE

COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITOR OF BRITTONIA

TAXONOMY, PHYLOGENY AND FLORISTICS

SPERMATOPHYTES

(See also under Morphology: **Morrison & Harris**; under Genetics: **Magoon et al., Mangelsdorf & Reeves**)

Avrorin, N. A. On the genus *Rhodococcum* (Rupr.) gen. nov. (Vacciniaceae). Bot. Zhur. **43**: 1719–1724. 1958. [In Russian.]

Barclay, Arthur S. New considerations in an old genus: *Datura*. Bot. Mus. Leafl. **18**: 245–272. *pl. 50–56*. 16 Jan 1959.

Barroso, G. M. *Araceae novae*. Arq. Jard. Bot. Rio de Janeiro **15**: 87–98. *pl. 1–14*. 1957 [Jan 1959].

Barroso, G. M. Borraginaceae, Verbenaceae, Solanaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 65–88. Dec 1957.

Barroso, G. M. Compositae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 171–241. Dec 1957.

Barroso, G. M. Compositae. O gonero *Stylotrichium* Matt. Arq. Jard. Bot. Rio de Janeiro **15**: 21–25. *pl. 1–3*. 1957 [Jan 1959].

Barroso, G. M. Gesneriaceae, Lentibulariaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 131–137. Dec 1957.

Barroso, G. M. Scrophulariaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 105–110. Dec 1957.

Berger, C. A., Witkus, E. R. & McMahon, R. M. Cytotaxonomic studies in the Leguminosae. Bull. Torrey Club **85**: 405–415. Nov–Dec 1958 [3 Feb 1959].

Bernard, *Frère* Jean-Paul. Le *Carex assiniboinensis* Boott et sa forme stolonifère. Nat. Canad. **86**: 11–19. Jan 1959.

Boivin, B. A new variety of *Thalictrum revolutum* DC. Am. Midl. Nat. **60**: 255. Jul 1958 [Feb 1959].

Bondar, Gregorio. Novo gênero e nove espécie de palmeiras da tribo Attaleini. Arq. Jard. Bot. Rio de Janeiro **15**: 47–55. 1957 [Jan 1959].

Brade, A. C. Begoniaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 151–170. *pl. 1–7*. Dec 1957.

Brade, A. C. Begonias novas do Brasil VIII. Arq. Jard. Bot. Rio de Janeiro **15**: 29–40. *pl. 1–6*. 1957 [Jan 1959].

Brade, A. C. Espécies novas da flora do Brasil. Arq. Jard. Bot. Rio de Janeiro **15**: 5–12. *pl. 1–7*. 1957 [Jan 1959].

Cabrera, Angel Lulio. Compositae brasilienses novae. Arq. Jard. Bot. Rio de Janeiro **15**: 69–76. *pl. 1–9*. 1957 [Jan 1959].

Cabrera, Angel Lulio. El género *Senecio* (Compositae) en Brasil, Paraguay e Uruguay. Arq. Jard. Bot. Rio de Janeiro **15**: 161–269. *pl. 1–24*. 1957 [Jan 1959].

Castellanos, A. Nótula sôbre el género *Pontederia* en Brasil. Arq. Jard. Bot. Rio de Janeiro **15**: 57–65. *pl. 1, 2*. 1957 [Jan 1959].

Clarkson, Roy B. Scotch heather in North America. Castanea **23**: 119–130. Dec 1958.

De Vattimo, I. "Lauraceae" do Estado do Rio de Janeiro. Parte I—Especies de Monte Sinai, Governador Portela. Arq. Jard. Bot. Rio de Janeiro **15**: 113–144. *pl. 1–15.* 1957 [Jan 1959].

De Vattimo, I. Ranunculaceae, Berberidaceae, Menispermaceae, Winteraceae, Anonaceae, Myristicaceae, Monimiaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 28–61. Dec 1957.

Dress, William J. Notes on the cultivated Compositae. 2. *Arnica.* Baileya **6**: 194–198. Dec 1958.

Dwyer, John D. The New World species of *Cynometra.* Ann. Missouri Bot. Gard. **45**: 313–345. Nov 1958 [6 Jan 1959].

Eaton, Richard J. Some interesting records from eastern Massachusetts. Rhodora **60**: 316–320. Dec 1958 [30 Jan 1959].

Ernst, Wallace R. Chromosome numbers of some western Papaveraceae. Contr. Dudley Herb. **5**: 109–115. 20 Dec 1958.

Fairbrothers, David E. Morphological variation of *Setaria faberii* and *S. viridis.* Brittonia **11**: 44–48. 15 Jan 1959.

Falcão, J. I. Convolvulaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 62–64. Dec 1957.

Ferris, Roxana S. Taxonomic notes on western plants. Contr. Dudley Herb. **5**: 99–108. 20 Dec 1958.

Gates, Burton N. *Cabomba caroliniana* grows in Worcester County, Massachusetts. Rhodora **60**: 321–323. Dec 1958 [30 Jan 1959].

Gomes, J. C. Bignoniaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 111–130. *1 pl.* Dec 1957.

Gould, Frank W. Chromosome numbers in southwestern grasses. Am. Jour. Bot. **45**: 757–767. 29 Dec 1958.

Harling, Gunnar. Monograph of the Cyclanthaceae. Acta Horti Berg. **18**: 1–428. *pl. 1–110.* 1958.

Hiroe, Minosuke & Constance, Lincoln. Umbelliferae of Japan. Univ. Calif. Publ. Bot. **30**: 1–144. 22 Oct 1958.

Hodge, W. H. The mountain cabbage palm of the Antilles. Principes **3**: 19–23. Jan 1959.

Howard, Richard A. A history of the genus *Coccoloba* in cultivation. Baileya **6**: 204–212. Dec 1958.

James, R. L. Miscellaneous notes and observations. Castanea **23**: 131–133. Dec 1958.

Ledin, R. Bruce, Kiem, Stanley C. & Read, Robert W. *Pseudophoenix* in Florida. Principes **3**: 23–29. Jan 1959.

Leese, Bernard M. Identification of Asiatic species of *Phaseolus* by seed characters. Am. Midl. Nat. **60**: 132–144. Jul 1958 [Feb 1959].

Lehr, J. Harry. Additions and corrections to a Flora of Rockland County, New York. Bull. Torrey Club **85**: 488, 489. Nov–Dec 1958 [3 Feb 1959].

Lewis, Walter H. A monograph of the genus *Rosa* in North America. I. *R. acicularis.* Brittonia **11**: 1–24. 15 Jan 1959.

Little, Elbert L. Four nomenclatural changes of woody plants. Phytologia **6**: 506, 507. 23 Jan 1959.

Little, Elbert L. & Pauley, Scott S. A natural hybrid between black and white spruce in Minnesota. Am. Midl. Nat. **60**: 202–211. Jul 1958 [Feb 1959].

Lutz, H. J. Observations on "diamond willow," with particular reference to its occurrence in Alaska. Am. Midl. Nat. **60**: 176–185. Jul 1958 [Feb 1959].

Mangelsdorf, Paul C. Reconstructing the ancestor of corn. Proc. Am. Philos. Soc. **102**: 454–463. 20 Oct 1958.

Mason, Charles T. A hybrid among the perennial gentians. Brittonia **11**: 40–43. 15 Jan 1959.

Medvedev, P. F. On the economic and biological significance of dioecious specimens of *Urtica dioica* L. Bot. Zhur. **43**: 1704–1707. 1958. [In Russian.]

Moldenke, Harold N. Materials toward a monograph of the genus *Citharexylum*. V. Phytologia **6**: 448–505. 23 Jan 1959.

Moldenke, Harold N. Notes on new and noteworthy plants, XXIII. Phytologia **6**: 446–448. 23 Jan 1959.

Monachino, Joseph. The spotted violet of High Tor. Bull. Torrey Club **85**: 483, 484. Nov–Dec 1958 [3 Feb 1959].

Moore, Raymond J. The status of *Caragana Boisii*. Baileya **6**: 188–193. Dec 1958.

Pereira, E. Labiatae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 89–104. Dec 1957.

Pereira, E. Saxifragaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 242, 243. Dec 1957.

Pike, Radcliffe & Hodgdon, A. R. A new *Rhododendron* station in Maine. Rhodora **60**: 328, 329. Dec 1958 [30 Jan 1959].

Proctor, George R. Further new records of Myrtaceae from Jamaica. Rhodora **60**: 323–326. Dec 1958 [30 Jan 1959].

Rambo, B. Die alte Südflora in Brasilien. Pesquisas **2**: 177–198. 1958.

Rambo, B. An historical approach to plant evolution. Pesquisas **2**: 199–222. 1958.

Rizzini, C. T. Acanthaceae. *In:* Flora do Itatiaia I. Rodriguésia **20**[32]: 138–150. Dec 1957.

Rizzini, C. T. & Occhioni, Paulo. Ação tóxica das *Dieffenbachia picta* e *D. seguine*. Rodriguésia **20**[32]: 1–19. *pl. 1–6*. Dec 1957.

Robinson, Franklin D. & Shanks, Royal E. Checklist of vascular aquatic plants of Tennessee. Jour. Tenn. Acad. **34**: 58–65. Jan 1959.

Sawant, Anand C. Cytogenetics of interspecific hybrids, *Lycopersicon esculentum* Mill. × *L. hirsutum* Humb. and Bonpl. Genetics **43**: 502–514. Jul [Nov] 1958.

Schultes, Richard Evans. Plantae colombianae XV. Plantae novae colombianae orientalis descriptiones. Bot. Mus. Leafl. **18**: 305–320. *pl. 58–62*. 16 Jan 1959.

Schultes, Richard Evans & Garay, Leslie A. On the validity of the generic name *Cochleanthes* Raf. Bot. Mus. Leafl. **18**: 321–327. 16 Jan 1959.

Sharma, Arun Kumar & Jash, Mira. Further investigation on the cytology of the Amaryllidaceae. Phyton Buenos Aires **11**: 103–110. Dec 1958.

Shaver, Jesse M. Heterophyllous leaves in the palmately lobed *Viola Egglestonii* Brainerd. Jour. Tenn. Acad. **34**: 40–46. *pl. 1–3*. Jan 1959.

Shaver, Jesse M. *Trillium sessile* in Tennessee. Jour. Tenn. Acad. **34**: 31–39. Jan 1959.

Silliman, Frances E. & Leisner, Robert S. An analysis of a colony of hybrid oaks. Am. Jour. Bot. **45**: 730–736. 29 Dec 1958.

Smith, Lyman B. Bromeliáceas notáveis do Herbário do Jardim Botânico do Rio de Janeiro—II. Arq. Jard. Bot. Rio de Janeiro **15**: 327–331. *1 pl.* 1957.

Smith, Lyman B. Notes on Bromeliaceae, XI. Phytologia **6**: 433–443. 23 Jan 1959.

Turner, B. L. & Fearing, O. S. Chromosome numbers in the Leguminosae. II. African species, including phyletic interpretations. Am. Jour. Bot. **46**: 49–57. 29 Jan 1959.

Wagner, W. H. The hybrid ragweed, *Ambrosia artemisiifolia* × *trifida*. Rhodora **60**: 309–316. Dec 1958 [30 Jan 1959].

Walther, Eric. Further notes on *Echeveria* [*viridissima, globuliflora,* spp. nov.]. Part V. Cact. Succ. Jour. **31**: 22–25. Jan 1959. Part VI. [megacalyx, juarezensis, spp. nov.] 50–53. Mar 1959.

Went, F. W. *Synthyris ranunculina*. Ann. Missouri Bot. Gard. **45**: 305–312. Nov 1958 [6 Jan 1959].

Whitaker, Thomas W. An interspecific cross in *Cucurbita* (*C. lundelliana* Bailey × *C. moschata* Duch.). Madroño **15**: 4–13. Jan 1959.

Wilson, Kenneth A. Typification of the genus *Forestiera* (Oleaceae). Rhodora **60**: 327, 328. Dec 1958 [30 Jan 1959].

Yuncker, T. G. Two recently described peperomias. Baileya **6**: 184–187. Dec 1958.

MORPHOLOGY
(including anatomy and cytology in part)

Bedesem, Paul P. Histogenetic effects of 2,3,5-triiodobenzoic acid on the shoot apices and leaf primordia of tomato. Bull. Torrey Club **85**: 434–472. Nov–Dec 1958 [3 Feb 1959].

Bierhorst, David W. The tracheary elements of *Equisetum* and observations on the ontogeny of the internodal xylem. Bull. Torrey Club **85**: 416–433. Nov–Dec 1958 [3 Feb 1959].

Blyth, Amélie. Origin of primary extraxylary stem fibers in dicotyledons. Univ. Calif. Publ. Bot. **30**: 145–232. *pl. 1–23*. 20 Nov 1958.

Cole, Herbert & Couch, Houston B. Cytological investigations of *Kabatiella caulivora*. Am. Jour. Bot. **46**: 12–16. 29 Jan 1959.

Copeland, Herbert F. The reproductive structures of *Schinus Molle* (Anacardiaceae). Madroño **15**: 14–25. Jan 1959.

Duncan, Robert E. & Persidsky, Maxim D. The achromatic figure during mitosis in maize endosperm. Am. Jour. Bot. **45**: 719–729. 29 Dec 1958.

Flint, Franklin F. Development of the megagametophyte in *Liquidambar styraciflua* L. Madroño **15**: 25–29. Jan 1959.

Graef, Philip E. The ovule and embryo sac of *Galax aphylla*. Va. Jour. Sci. **9**: 319–322. Jul 1957.

Lewis, K. Roderick. Chromosome structure and organization in *Pellia epiphyl*[*l*]*a*. Phyton Buenos Aires **11**: 29–37. Sep 1958.

Lück, Hermann B. & Lück, Jacqueline. Entwicklungsmechanische Untersuchungen an Epidermiszellen. I. Einleitende Studien sur Anatomie von Gramineen-spaltöffnungen. Phyton Buenos Aires **11**: 39–51. Sep 1958.

McWilliam, J. R. & Mergen, François. Cytology of fertilization in *Pinus*. Bot. Gaz. **119**: 246–249. Jun [Oct] 1958.

Morrison, T. M. & Harris, G. P. Root nodules in *Discaria toumatou* Raoul Choix. Nature **182**: 1746, 1747. 20 Dec 1958.

Olive, Lindsay S. De Bary bubbles in ascospores of *Sordaria fimicola*. Bull. Torrey Club **85**: 473–475. Nov–Dec 1958 [3 Feb 1959].

Postlethwait, S. N. & Curtis, Roy W. Histology of malformations produced on bean plants by culture filtrate of *Aspergillus niger*. Am. Jour. Bot. **46**: 31–35. 29 Jan 1959.

GENETICS
(including cytogenetics)
(See also under Spermatophytes: **Sawant**; under Plant Physiology: **Highkin**; **Muir et al.**)

Ahuja, M. R. The nucleolar chromosomes of *Allium cepa*. Jour. Hered. **49**: 247–249. Sep–Oct 1958 [Jan 1959].

Beard, B. H., Haskins, F. A. & Gardner, C. O. Comparison of effects of X-rays and thermal neutrons on dormant seeds of barley, maize, mustard, and safflower. Genetics **43**: 728–736. Sep 1958 [Jan 1959].

Bird, L. S. & Hadley, Henry H. A statistical study of the inheritance of Stoneville 20 resistance to the bacterial blight disease of cotton in the presence of *Xanthomomas malvacearum* races 1 and 2. Genetics **43**: 750–767. Sep 1958 [Jan 1959].

Brink, R. Alexander. A stable somatic mutation to colorless from variegated pericarp in maize. Genetics **43**: 435–447. Jul [Nov] 1958.

Campos, Filomena F. & Morgan, D. T. Haploid pepper from a sperm. Jour. Hered. **49**: 134–137. Jul–Aug [Nov] 1958.

Comstock, R. E., Kelleher, Therese & Morrow, E. B. Genetic variation in an asexual species, the garden strawberry. Genetics **43**: 634–646. Sep 1958 [Jan 1959].

Emmerling, M. H. Evidence of non-disjunction of abnormal chromosome 10 [in *Zea mays*]. Jour. Hered. **49**: 203–207. Sep–Oct 1958 [Jan 1959].

Fabergé, A. C. Relation between chromatid-type and chromosome-type breakage-fusion-bridge cycles in maize endosperm. Genetics **43**: 737–749. Sep 1958 [Jan 1959].

Flagg, Raymond O. A mutation and an inversion in *Rhoeo discolor*. Jour. Hered. **49**: 185–188. Jul–Aug [Nov] 1958.

Hanson, C. H., Cope, W. A. & Brinkley, R. M. Chemical changes in *Lespedeza* associated with induced polyploidy. Am. Jour. Bot. **46**: 36–39. 29 Jan 1959.

Haus, Thilo E. A linkage between two sections of a chromosome in barley. Jour. Hered. **49**: 179, 180. Jul–Aug [Nov] 1958.

Joyner, J. Frank & Pate, James B. The inheritance of petal spot in kenaf. Jour. Hered. **49**: 152. Jul–Aug [Nov] 1958.

Kedharnath, S. & Brink, R. A. Transposition and the stability of modulator in maize. Genetics **43**: 695–704. Sep 1958 [Jan 1959].

Korab, Mary. Two rare chromosomal abnormalities in *Oryza sativa* L. induced by X-rays. Phyton Buenos Aires **11**: 97–101. Dec 1958.

Lee, Addison E. Comparative growth of excised tomato roots of clones carrying dwarf and normal alleles. Am. Jour. Bot. **45**: 744–748. 29 Dec 1958.

Magoon, M. L., Cooper, D. C. & Hougas, R. W. Induced polyploids of solanums and their crossability with *S. tuberosum*. Bot. Gaz. **119**: 224–231. Jun [Oct] 1958.

Magoon, M. L., Hougas, R. W. & Cooper, D. C. Cytogenetic studies of tetraploid hybrids in *Solanum*. Jour. Hered. **49**: 170–178. Jul–Aug [Nov] 1958.

Mangelsdorf, Paul C. & Reeves, Robert G. The origin of corn. I. Pod corn, the ancestral form. Bot. Mus. Leafl. **18**: 329–356. 20 Feb 1959.

Maunder, A. B. & Pickett, R. C. The genetic inheritance of cytoplasmic-genetic male sterility in grain sorghum. Agron. Jour. **51**: 47–49. Jan 1959.

Raper, John R. & Miles, Philip G. The genetics of *Schizophyllum commune*. Genetics **43**: 530–546. Jul [Nov] 1958.

Rick, Charles M., Thompson, Anson E. & Brauer, Oscar. Genetics and development of an unstable chlorophyll deficiency in *Lycoperiscon esculentum*. Am. Jour. Bot. **46**: 1–11. 29 Jan 1959.

Russell, W. A. & Hooker, A. L. Inheritance of resistance in corn to rust, *Puccinia sorghi* Schw., and genetic relationships among different sources of resistance. Agron. Jour. **51**: 31–34. Jan 1959.

Sagawa, Yoneo. The production of polyploid Easter lilies. I. Triploids. Jour. Hered. **49**: 194–198. Sep–Oct 1958 [Jan 1959].

Sarvella, Patricia. Multivalent formation and genetic segregation in some allopolyploid *Gossypium* hybrids. Genetics **43**: 601–619. Sep 1958 [Jan 1959].

Schwartz, Drew. A new temperature-sensitive allele at the sticky locus in maize. Jour. Hered. **49**: 149–152. Jul–Aug [Nov] 1958.

Soost, Robert K. Progenies from sesquidiploid F_1 hybrids. Jour. Hered. **49**: 208–213. Sep–Oct 1958 [Jan 1959].

Takahashi, Toshiaki. Complementary genes controlling homothallism in *Saccharomyces*. Genetics **43**: 705–714. Sep 1958 [Jan 1959].

Taylor, J. Herbert. Sister chromatid exchanges in tritium-labeled chromosomes. Genetics **43**: 515–529. Jul [Nov] 1958.

Wolff, Sheldon & Luippold, H. E. Modification of chromosomal aberration yield [in *Tradescantia paludosa*] by postirradiation treatment. Genetics **43**: 493–501. Jul [Nov] 1958.

Zirkle, Conway. The first recognized plant hybrid? Jour. Hered. **49**: 137, 138. Jul–Aug [Nov] 1958.

PLANT PHYSIOLOGY

Abrams, R. & Frey, K. J. Effect of recurrent X-radiation on germination and seedling vigor in oats. Proc. Iowa Acad. **65**: 174–183. 1958.

Alston, Ralph E. An investigation of the purple vacuolar pigment of *Zygogonium ericetorum* and the status of "algal anthocyanins" and "phycoporphyrins." Am. Jour. Bot. **45**: 688–692. 22 Nov 1958.

Applegate, Howard G. Photoperiod and temperature effects on gibberellin-sprayed plants. Bot. Gaz. **120**: 39–43. Sep [14 Nov] 1958.

Avers, Charlotte J. Histochemical localization of enzyme activity in the root epidermis of *Phleum pratense*. Am. Jour. Bot. **45**: 609–613. Oct [19 Nov] 1958.

Bailey, Paul C. The influence of some atmospheric gases upon the rate of mitosis in root tips of *Trillium sessile* L. Cytologia **23**: 211–217. 5 Jun 1958.

Bell, Thomas A. & Etchells, John L. Pectinase inhibitor in grape leaves. Bot. Gaz. **119**: 192–196. Mar [16 Mai] 1958.

Biddulph, Susann, Biddulph O., & Cory, R. Visual indications of upward movement of foliar-applied D^{32} and C^{14} in the phloem of the bean stem. Am. Jour. Bot. **45**: 648–652. Oct [19 Nov] 1958.

Bonde, Erik K. & Moore, Thomas C. Effects of gibberellic acid on the growth and flowering of telephone peas. Physiol. Plant. **11**: 451–456. 1958.

Brady, Lynn R. & Tyler, Varro E. Biosynthesis of hordenine in tissue homogenates of *Panicum miliaceum* L. Pl. Physiol. **33**: 334–338. Sep [Nov] 1958.

Brian, P. W. *et al.* Gibberellic acid, Part VI. The biological activity of allogibberic acid and its identity with gibberellin B. Pl. Physiol. **33**: 329–333. Sep [Nov] 1958.

Chapman, H. W. Tuberization in the potato plant. Physiol. Plant. **11**: 215–224. 1958.

Cleland, Robert. A separation of auxin-induced cell wall loosening into its plastic and elastic components. Physiol. Plant. **11**: 599–609. 1958.

Clum, Harold H. & Nason, Alvin. Triphosphopyridine nucleotide diaphorase from wheat germ. Pl. Physiol. **33**: 354–360. Sep [Nov] 1958.

Cochrane, Vincent W. & Tull, Dade L. W. Uranium and spore respiration in *Neurospora sitophila*. Phytopathology **48**: 623–628. Nov 1958.

Cotrufo, C. & Levitt, J. Investigations of the cytoplasmic particulates and proteins of potato tubers VI. Nitrogen changes associated with emergence of potato tubers from the rest period. Physiol. Plant. **11**: 240–248. 1958.

Davis, Norman D. An initial study of pathways of carbon metabolism in *Hansenula anomala* (Hansen) Sydow. Mycologia **50**: 770–776. Sep–Oct [Dec] 1958.

Dugger, W. M., Humphreys, T. E. & Calhoun, Barbara. Influence of N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide (captan) on higher plants. I. Effect on the morphology and gross metabolism of root tissue. Am. Jour. Bot. **45**: 683–687. 22 Nov 1958. II, Effect on specific enzyme systems. **46**: 151–156 16 Mar 1959.

Enright, L. J. Response of *Metasequoia* cuttings to growth regulator treatments. Bot. Gaz. **120**: 53, 54. Sep [14 Nov] 1958.

Ergle, David R. Compositional factors associated with the growth responses of young cotton plants to gibberellic acid. Pl. Physiol. **33**: 344–346. Sep [Nov] 1958.

Erickson, Louis C., DeWolfe, Thomas A. & Brannaman, B. L. Growth of some citrus-fruit pathogens as affected by 2,4-D and 2,4,5-T. Bot. Gaz. **120**: 31–36. Sep [14 Nov] 1958.

Fraser, Ian M. & Fujikawa, Byron S. The growth-promoting effect of several amino acids on the common cultivated mushroom, *Agaricus bisporus*. Mycologia **50**: 538–549. Jul–Aug [6 Oct] 1958.

Frederick, Jerome F. Use of chelation phenomenon in studies of the structure and action mechanism of *Oscillatoria* phosphorylase. Physiol. Plant. **11**: 493–502. 1958.

Gallicchio, Virginia & Gottlieb, David. The biosynthesis of chloramphenicol [in *Streptomyces venezuelae*]. III. Effects of micronutrients on synthesis. Mycologia **50**: 490–496. Jul–Aug [6 Oct] 1958.

Gordon, Solon A. & Moss, Ronald A. The activity of S-(carboxymethyl)-dimethyl-dithiocarbamate as an auxin. Physiol. Plant. **11**: 208–214. 1958.

Griesel, Wesley O. & Biale, Jacob B. Respiratory trends in perianth segments of *Magnolia grandiflora*. Am. Jour. Bot. **45**: 660–663. 22 Nov 1958.

Halldal, Per. Pigment formation and growth in blue-green algae in crossed gradients of light intensity and temperature. Physiol. Plant. **11**: 401–420. 1958.

Hayward, H. E. & Bernstein, L. Plant growth relationships on salt-affected soils. Bot. Rev. **24**: 584–635. Oct–Dec 1958.

Highkin, H. R. Temperature-induced variability in peas. Am. Jour. Bot. **45**: 626–631. Oct [19 Nov] 1958.

Jacobs, William P. Further studies of the relation between auxin and abscission of *Coleus* leaves. Am. Jour. Bot. **45**: 673–675. 22 Nov 1958.

Jambor, Béla, Roberts, Lorin W. & Dévay, M. Experiments on the penetration and reduction of 2,3-triphenyltetrazolium chloride in plant tissues. Phyton Buenos Aires **10**: 89–98. Jun 1958.

Johnson, G. T. Oxidation of fatty acids by cell suspensions of *Spicaria violacea*. Mycologia **50**: 677–680. Sep–Oct [Dec] 1958.

Kasting, R. & Delwiche, C. C. Ornithine, citrulline, and arginine metabolism in watermelon seedlings. Pl. Physiol. **33**: 350–354. Sep [Nov] 1958.

Keck, Konrad & Clauss, Heinz. Nuclear control of enzyme synthesis in *Acetabularia*. Bot. Gaz. **120**: 43–49. Sep [14 Nov] 1958.

Klein, S. & Preiss, John W. Depth controlled deuteron irradiation of *Lactuca sativa* seeds. I. Effects on germination and growth. Pl. Physiol. **33**: 321–325. Sep [Nov] 1958.

Lambert, R. G. & Linck, A. J. Effects of high temperature on yield of peas. Pl. Physiol. **33**: 347–350. Sep [Nov] 1958.

Lanning, F. C., Ponnaiva, B. W. X. & Crumpton, C. F. The chemical nature of silica in plants. Pl. Physiol. **33**: 339–343. Sep [Nov] 1958.

Lee, Addison E. The effects of various treatments in different genetic lines of excised tomato roots grown in culture. Bull. Torrey Club **85**: 335–340. Sep–Oct [12 Nov] 1958.

Lieberman, Morris *et al.* Biochemical studies of chilling injury in sweetpotatoes. Pl. Physiol. **33**: 307–311. Sep [Nov] 1958.

Lincoln, R. G., Raven, K. A. & Hamner, K. C. Certain factors influencing expression of the flowering stimulus in *Xanthium*. Part II. Relative contribution of buds and leaves to effectiveness of inductive treatment. Bot. Gaz. **119**: 179–185. Mar [16 Mai] 1958.

Lockhart, James A. The influence of red and far-red radiation on the response of *Phaseolus vulgaris* to gibberellic acid. Physiol. Plant. **11**: 487–492. 1958.

Lockhart, James A. The response of various species of higher plants to light and gibberellic acid. Physiol. Plant. **11**: 478–486. 1958.

McIlrath, Wayne J. & Bogorad, Lawrence. Photoperiodic floral induction of *Xanthium* and germination of lettuce seeds implanted in the petioles. Bot. Gaz. **119**: 186–191. Mar [16 May] 1958.

Meier, Dorothy. Observations on the relation of molds to the epidermis of the [human] foot. Bull. Torrey Club **85**: 363–367. Sep–Oct [12 Nov] 1958.

Milner, Max, French, C. Stacey & Milner, H. W. Effect of petroleum ether extraction and readdition of various compounds on the photochemical activity of isolated chloroplasts. Pl. Physiol. **33**: 367–372. Sep [Nov] 1958.

Misra, Gadadhar. Photoperiodic response of some newly evolved strains of wheat. Bull. Torrey Club **85**: 347–358. Sep–Oct [12 Nov] 1958.

Monselise, Shaul P. & Went, Frits W. Effects of temperature on growth and dry matter accumulation of peas. Pl. Physiol. **33**: 372–374. Sep [Nov] 1958.

Muir, W. H., Hildebrandt, A. C. & Riker, A. J. The preparation, isolation, and growth in culture of single cells from higher plants. Am. Jour. Bot. **45**: 589–597. Oct [19 Nov] 1958.

Muller, H. G. The constricting ring mechanism of two predacious Hyphomycetes. Brit. Mycol. Soc. Trans. **41**: 341–364. Sep 1958.

Muzik, T. J. & Cruzado, H. J. Differentiation of bean internode segments in tissue culture with added indoleacetic acid, 2,4-dichlorophenoxyacetic acid, and maleic hydrazide. Bot. Gaz. **120**: 57–59. Sep [14 Nov] 1958.

Nanda, K. K. & Hamner, K. C. Studies on the nature of the endogenous rhythm affecting photoperiodic response of Biloxi soybean. Bot. Gaz. **120**: 14–25. Sep [14 Nov] 1958.

Naylor, A. W., Rabson, R. & Tolbert, N. E. Aspartic-C^{14} acid metabolism in leaves, roots, and stems. Physiol. Plant. **11**: 537–547. 1958.

Nicholas, D. J. D. & Goodman, Tessa. The effects of deficiencies of zinc and iron on some enzyme systems in *Neurospora*. Jour. Exp. Bot. **9**: 97–108. Feb 1958.

Nickell, Louis G. Growth effects of antibiotics on plant cells and their reaction to a modified Gram strain. Phyton Buenos Aires **11**: 93–96. Sep 1958.

Palmer, J. H. Studies in the behaviour of the rhizome of *Agropyron repens* (L.) Beauv. New Phytol. **57**: 145–159. Jul 1958.

Plummer, T. H. & Tomes, M. L. Effects of indoleacetic acid and gibberellic acid on normal and dwarf tomatoes. Bot. Gaz. **119**: 197–200. Mar [Mai] 1958.

Preiss, John W. & Klein, S. Depth controlled deuteron irradiation of *Lactuca sativa* seeds. II. Energy loss in the outer seed layers. Pl. Physiol. **33**: 326–329. Sep [Nov] 1958.

Reinhold, Leonora & Powell, R. G. The stimulatory effect of indole-3-acetic acid on the uptake of amino-acids by tissue of *Helianthus annuus*. Jour. Exp. Bot. **9**: 82–96. Feb 1958.

Robbins, William J. & Hervey, Annette. Wood, tomato and malt extracts and growth of some Basidiomycetes. Mycologia **50**: 745–752. Sep–Oct [Dec] 1958.

Schieferstein, R. H. & Loomis, W. E. Growth and differentiation of the epidermal wall. Proc. Iowa Acad. **65**: 163–165. 1958.

Semeniuk, Peter. Effects of temperature on seed production of *Matthiola incana* (L.) R. Br. Jour. Hered. **49**: 161–166. Jul–Aug [Nov] 1958.

Shrift, Alex. Biological activities of selenium compounds. Bot. Rev. **24**: 550–583. Oct–Dec 1958.

Shropshire, Walter & Withrow, Robert B. Action spectrum of phototropic tip-curvature of *Avena*. Pl. Physiol. **33**: 360–365. Sep [Nov] 1958.

Sinclair, Walton B. & Jolliffe, Virgil A. Changes in pectic constituents of Valencia oranges during growth and development. Bot. Gaz. **119**: 217–223. Jun [30 Sep] 1958.

Solt, Marie L. & Dawson, R. F. Production, translocation and accumulation of alkaloids in tobacco scions grafted to tomato rootstocks. Pl. Physiol. **33**: 375–381. Sep [Nov] 1958.

Sorokin, Constantine. The effect of the past history of cells of *Chlorella* on their photosynthetic capacity. Physiol. Plant. **11**: 275–283. 1958

Squires, Craig L., Stumpf, P. K. & Schmid, Charlotte. Effect of bicarbonate on the enzymic synthesis of long chain fatty acids. Pl. Physiol. **33**: 365, 366. Sep [Nov] 1958.

Stanley, Robert G. Gross respiratory and water uptake patterns in germinating sugar pine seed. Physiol. Plant. **11**: 503–515. 1958.

Steward, F. C., Bidwell, R. G. S. & Yemm, E. W. Nitrogen metabolism, respiration, and growth of cultured plant tissue. Part I. Experimental design, techniques, and recorded data. Part II. The interpretation of specific activity data in tracer experiments. Part III. Nitrogen metabolism and respiration of carrot tissue explants as revealed by experiments with C^{14} labelled substrates. Jour. Exp. Bot. **9**: 11–49. Feb 1958.

Steward, F. C., Mapes, Marion O. & Smith, Joan. Growth and organized development of cultured cells. I. Growth and division of freely suspended cells. Am. Jour. Bot. **45**: 693–703. 22 Nov 1958. II. Organization in cultures grown from freely suspended cells. 705–708. 29 Dec.

Steward, F. C., Thompson, J. F. & Pollard, J. K. Contrasts in the nitrogenous composition of rapidly growing and non-growing plant tissues. Jour. Exp. Bot. **9**: 1–10. Feb 1958.

Sun, C. N. The survival of excised pea seedlings after drying and freezing in liquid nitrogen. Bot. Gaz. **119**: 234–236. Jun [30 Sep] 1958.

Sussex, I. M. & Steeves, Taylor A. Experiments on the control of fertility of fern leaves in sterile culture. Bot. Gaz. **119**: 203–208. Jun [30 Sep] 1958.

Tamaoki, Taiki & Ullstrup, Arnold J. Cultivation in vitro of excised endosperm and meristem tissues of corn. Bull. Torrey Club **85**: 260–272. Jul–Aug [16 Oct] 1958.

Tarén, Niina. Factors regulating the initial development of gemmae in *Marchantia polymorpha*. Bryologist **61**: 191–204. Sep [Oct] 1958.

Thimann, Kenneth V. Auxin activity of some indole derivatives. Pl. Physiol. **33**: 311–320. Sep [Nov] 1958.

Todd, Glenn W. Effect of low concentrations of ozone on the enzymes, catalase, peroxidase, papain and urease. Physiol. Plant. **11**: 457–463. 1958.

Tomes, M. L., Quackenbush, F. W. & Kargl, T. E. Synthesis of β-carotene in the tomato fruit. Bot. Gaz. **119**: 250–253. Jun [30 Sep] 1958.

Trainor, Francis R. Control of sexuality in *Chlamydomonas chlamydogama*. Am. Jour. Bot. **45**: 621–626. Oct [19 Nov] 1958.

Wetherell, D. F. Obligate phototrophy in *Chlamydomonas eugametos*. Physiol. Plant. **11**: 260–274. 1958.

Wilson, Eugene M. Aspartic and glutamic acid as self-inhibitors of uredospore germination. Phytopathology **48**: 595–600. Nov 1958.

PHYTOPATHOLOGY

(See also under Genetics: **Bird & Hadley; Russell & Hooker;** under Plant Physiology: **Erickson et al.; Wilson**)

Boyce, John S. Twig blight of eastern white pine caused by *Monochaetia pinicola*. Phytopathology **48**: 516, 517. Sep [27 Oct] 1958.

Corbett, M. K. Diseases of the coconut palm. Principes **3**: 5–12, 39. Jan 1959.

Erwin, Donald C. *Fusarium lateritium* f. *ciceri*, incitant of *Fusarium* wilt of *Cicer arietinum*. Phytopathology **48**: 498–501. Sep [27 Oct] 1958.

Goth, R. W., Rowell, J. B. & Kernkamp, M. F. Behavior of solopathogens from interspecific crosses of some *Sphacelotheca* spp. Phytopathology **48**: 494–497. Sep [27 Oct] 1958.

Guba, E. F. The peach constriction disease. Phytopathology **48**: 522–524. Sep [27 Oct] 1958.

Halpin, J. E. & Hanson, E. W. Effect of age of seedlings of alfalfa, red clover, Ladino white clover, and sweetclover on susceptibility to *Pythium*. Phytopathology **48**: 481–485. Sep [27 Oct] 1958.

Ivanoff, S. S. The water-soak method of plant disease control in relation to microbial activities, oxygen supply, and food availability. Phytopathology **48**: 502–508. Sep [27 Oct] 1958.

Kantack, E. J. & Martin, W. J. Effect of internal cork on yield and grade of sweet potato roots. Phytopathology **48**: 521, 522. Sep [27 Oct] 1958.

Kilpatrick, R. A. Curvularia leaf blight of clovers and its causal agent, *Curvularia trifolii*. Phytopathology **48**: 513–515. Sep [27 Oct] 1958.

Klotz, L. J., DeWolfe, T. A. & Wong, Po-Ping. Influence of 2 varieties of citrus scions on the pathogenicity of 3 isolates of *Phytophthora parasitica* to sweet orange rootstock. Phytopathology **48**: 520, 521. Sep [27 Oct] 1958.

Knorr, L. C., Suit, R. F. & DuCharme, E. P. Handbook of citrus diseases in Florida. Fla. Exp. Sta. Bull. **587**: 1–157. Jun 1957.

Mitchell, J. W., Smale, B. C. & Porter, F. M. Effect of some substituted carbamates on symptom development in stems of bean plants infected with southern bean mosaic virus. Phytopathology **48**: 517, 518. Sep [27 Oct] 1958.

Partyka, R. E. & Mai, W. F. Nematocides in relation to sclerotial germination in *Sclerotinia sclerotiorum*. Phytopathology **48**: 519, 520. Sep [27 Oct] 1958.

Schein, Richard D. Pathogenic specialization in *Rhynchosporium secalis*. Phytopathology **48**: 477–480. Sep [27 Oct] 1958.

Sharp, E. L. et al. Some critical factors involved in establishment of *Puccinia graminis* var. *tritici*. Phytopathology **48**: 469–474. Sep [27 Oct] 1958.

Steward, F. C. Growth and organized development of cultured cells. III. Interpretations of the growth from free cell to carrot plant. Am. Jour. Bot. **45**: 709–713. 29 Dec 1958.

Wagnon, H. Keith, Breece, James R. & Schlocker, Archie. Stubby twig, a new virus disease of peach and nectarine in California. Phytopathology **48**: 465–468. Sep [27 Oct] 1958.

Whitehead, Marvin D. Pathology and pathological histology of downy mildew, *Sclerophthora macrospora*, on six graminicolous hosts. Phytopathology **48**: 485–493. Sep [27 Oct] 1958.

Wilcoxson, Roy D. Peduncle sclerenchyma tissue of nugget wheat in relation to development of pustules of *Puccinia graminis* var. *tritici*. Phytopathology **48**: 518, 519. Sep [27 Oct] 1958.

Wolf, Frederick T. *Peronospora parasitica* on *Leavenworthia*. Jour. Tenn. Acad. **34**: 3, 4. Jan 1959.

GENERAL BOTANY
(including biography and nomenclature)

Baehni, C. Les relations de Rafinesque et d'Augustin-Pyramus de Candolle. *In:* Botanistes français en Amérique du Nord 137–147. 1957.

Bonnault, C. de. La Galissonnière et sa contribution à la botanique du Canada. *In:* Botanistes français en Amérique du Nord 171–177. 1957.

Camus, Aimée. Contribution française à l'étude des graminées de l'Amérique du Nord au XVIII^{e} siècle et dans le première moitié du XIX^{e} siècle. *In:* Botanistes français en Amérique du Nord 107–121. 1957.

Cardew, F. Maund's *Botanic garden* and other works. Jour. Soc. Bibliogr. Nat. Hist. **3**: 321–324. Dec 1958.

Chinard, Gilbert. Les Michaux et leurs précurseurs. *In:* Botanistes français en Amérique du Nord 263–284. *pl. 32.* 1957.

Dawson, Warren R. Dawson Turner, F.R.S. (1775–1858). Jour. Soc. Bibliogr. Nat. Hist. **3**: 303–310. *pl. 1–4.* Dec 1958.

Duprat, Gabriella. Essai sur les sources manuscrites conservées au Museum National d' Histoire Naturelle. *In:* Botanistes français en Amérique du Nord 231–252. *pl. 24–31.* 1957.

Ewan, J. L'activité des premiers explorateurs français dans le S. E. des Etats-Unis. *In:* Botanistes français en Amérique du Nord 17–40. *pl. 1–4.* 1957.

Fuchs, H. P. [Professor Wilhelm Herter . . .] Am. Fern Jour. **48**: 168, 169. 31 Dec 1958.

Galoux, A. Les grandes étapes de l'introduction des arbres nord-américains en Belgique. *In:* Botanistes français en Amérique du Nord 315–328. 1957.

Gaussen, H. Le "Traité général des conifères" de E. A. Carrière et l'Amérique du Nord. *In:* Botanistes français en Amérique du Nord 253–261. 1957.

Gordon, Solon A. & Hendricks, Sterling B. Robert Bruce Withrow, 1905–1958. Pl. Physiol. **33**: 447, 448. Nov [Dec] 1958.

Graves, Arthur H. Alfred Gundersen. Bull. Torrey Club **85**: 484–487. Nov–Dec 1958 [3 Feb 1959].

Greene, S. W. C. König and J. Sims' *Annals of botany*. Jour. Soc. Bibliogr. Nat. Hist. **3**: 319, 320. Dec 1958.

Guillaumin, A. & Chaudun, V. L'introduction en France des plantes horticoles originaires de l'Amérique du Nord avant 1850. *In:* Botanistes français en Amérique du Nord 123–135. 1957.

Guinier, Ph. À propos de la comunication de M. Schramm: influence actuelle et passée de F. A. Michaux sur la foresterie et la recherche forestière en Amérique. *In:* Botanistes français en Amérique du Nord 301. 1957.

Guinier, Ph. Ce que les jardins er les forêts de France doivent aux forêts américaines. *In:* Botanistes français en Amérique du Nord 329–337. 1957.

Jovet, Paul & Willmann, Robert. A. Trécul, botaniste français (1818–1896). Biographie sommaire. Voyage en Amérique du Nord (1848–1850). *In:* Botanistes français en Amérique du Nord 83–106. *pl. 9, map.* 1957.

Leroy, Jean F. Le premier explorateur de Terre-Neuve et des Îles Saint-Pierre et Miquelon: Bachelot de la Pylaie (1786–1856). *In:* Botanistes français en Amérique du Nord 203–230. *pl. 15–23.* 1957.

Leroy, Jean F. Note sur l'introduction des plantes américaines en France dans la première moitié du XVIII[e] siècle. (Bernard de Jussieu et Prat). *In:* Botanistes français en Amérique du Nord 285, 286. 1957.

Loehwing, W. F. Joseph Fisher Stanfield, 1901–1958. Pl. Physiol. **33**: 448, 449. Nov [Dec] 1958.

Motte, Jean. Matériaux inédits, préparés par Delile pour une flore de l'Amérique du Nord. *In:* Botanistes français en Amérique du Nord 53–82. *pl. 8.* 1957.

Nute, Grace Lee. Lamare-Picquot en Amérique du Nord. *In:* Botanistes français en Amérique du Nord 161–170. *pl. 13, 14.* 1957.

Pourtet, Jean. Rôle et importance des essences forestières américaines dans les techniques actuelles de la foresterie française. *In:* Botanistes français en Amérique du Nord 339–348. 1957.

Rautenberg, Leonard E. J. C. A. Mayer's *Einheimische Giftgewächse* (1798–1801). Jour. Soc. Bibliogr. Nat. Hist. **3**: 325–327. *pl. 5–7.* Dec 1958.

Raymond, Marcel. Auguste Plée (1787–1825) et la flore américaine. *In:* Botanistes français en Amérique du Nord 193–201. 1957.

Raymond, Marcel. Bourgeau en Amérique du Nord. *In:* Botanistes français en Amérique du Nord 189–191. 1957.

Richards, Adrian F. & Brattstrom, Bayard H. Bibliography, cartography, discovery, and exploration of the Islas Revillagigedo. Proc. Calif. Acad. **19**: 315–360. 5 Jan 1959.

Robbins, William J. Les botanistes français et la flore du Nord-est des États-unis: J. G. Milbert et Elias Durand. *In:* Botanistes français en Amérique du Nord 41–51. *pl. 4 bis.* 1957.

Rousseau, Jacques. Michel Sarrazin, Jean-François Gaulthier et l'étude prélinnéenne de la flore canadienne. *In:* Botanistes français en Amérique du Nord 149–157. 1957.

Schramm, J. R. Influence—passée et présente—de François-André Michaux sur la foresterie et la recherche forestière en Amérique. *In:* Botanistes français en Amérique du Nord 287–300. 1957.

Skottsberg, C. Linné, Kalm et l'étude de la flore nord-américaine au XVIII[e] siecle. *In:* Botanistes français en Amérique du Nord 179–187. 1957.

Stearn, William T. Publication of Catesby's *Natural history of Carolina.* Jour. Soc. Bibliogr. Nat. Hist. **3**: 328. Dec 1958.

Tryon, Alice F. Una Foster Weatherby. Am. Fern Jour. **48**: 129–135. 31 Dec 1958.

Uscategui M., Nestor. The present distribution of narcotics and stimulants amongst the Indian tribes of Colombia. Bot. Mus. Leafl. **18**: 273–304. *pl. 57.* 16 Jan 1959.

Wood, R. F. & Matthews, J. D. Arbres nord-américains et sylviculture anglaise. *In:* Botanistes français en Amérique du Nord 303–313. 1957.